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Original Articles PAGE

DESIRABILITY OR OTHERWISE OF INTERCULTURING IN ROW CROPS[1]

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Received for Publication on August 13, 1957

Interculturing of crops that are seeded or transplanted in rows is a well established agricultural practice throughout the world. The operation is carried out with a view to better the quality and increase the quantity of the crop produced with one or more of the following benefits derived from it :

(i) Control of weeds,

(ii) Increase in infiltration rate,

(iii) Reduction in surface evaporation, and

(iv) Proper aeration of the soil.

Among the crops grown on the farms of Charotar tract of Middle Gujarat, interculturing is carried out more frequently in tobacco.

Although interculturing has been taken up as an essential operation, its specific contribution towards crop production seems to have remained obscure. For last few years, a controversy has arisen with regard to the importance of interculturing operation in successful raising of crops, especially where weeds are not a problem.

In view of the contrary views regarding the desirability or otherwise of interculturing, it was deemed worthwhile to carry out an investigation at the Institute of Agriculture, Anand, to study the effects of interculturing on the quality and quantity of the crop produced.

Sturtevant [1887], one of the first to study the effects of inter-row-cultivation on the crop yields, found that the cultivation was not beneficial to corn plants except in the control of weeds. This view was supported by Cates and Cox [1912], Mosier and Gustafson [1915], Call and Sewel [1917] and several other workers.

Thompson [1927] who studied the effects of inter-row-cultivation on the yields of vegetable crops, conservation of soil moisture and nitrate formation in the soil came to the same conclusion after six years of experimentation. Pereira [1941] observed that potato yields did neither increase by intensive cultivation nor decreased by withholding what are considered as normal cultivations.

Ronillard [1957] reported the ineffectiveness of inter-row-cultivation of sugarcane on growth, stooling, uptake of nutrients and yields of cane and sugar. Bederker [1955] observed that there was some advantage in interculturing cotton once in three years.

King [1892], Harris and Yao [1923] and Hays and Smith [1900] observed beneficial effects of inter-row-cultivation or soil mulch where either the water table was within 10 feet or the soils were hard or unploughed. On the other hand, Young [1912], Call and Sewel [1917], Patel [1955], Harring [1921] and Shaw [1921] found little or no beneficial effect of soil mulches in conservation of soil moisture.

MATERIAL AND METHODS

The present investigation was undertaken at the Institute of Agriculture, Anand, in the heart of Charotar tract of Bombay State. The studies were confined to rainfed tobacco Variety *K*.49 and irrigated brinjal. The soil of the experimental plots was sandy loam of deep alluvial type, fairly rich in organic matter, well drained and fairly retentive of moisture.

[1] Portion of a dissertation presented in partial fulfilment of the requirements of the degree of Master of Science in Agriculture at Gujarat University, Ahmedabad (1957).

Tobacco

The design of the experiment was completely randomized block with four treatments replicated five times.

The treatments were :

A : no-interculturing ;

B : two interculturing; first after the establishment of the crop and the second just prior to topping ;

C : interculturing at 10-day interval ; and

D : interculturing at 5-day interval.

The total number of interculturing in respective treatments was 0, 2, 8, and 16 in 1955-56 as against 0, 2, 3 and 5 in 1956-57 due to the rapid growth of plants which prevented further interculturing.

Seedlings of tobacco were transplanted at a distance of 3 ft. × 3 ft. in the experimental plots 45 ft. × 30 ft. in size on the 14th August, 1955 and the 24th August, 1956.

Interculturing was carried out regularly as per schedule after the transplants were established well in the field till the spread of the plants made the operation difficult. All interculturings were carried out as per schedule and each time it was done in both the directions, along and across the rows. Weeds were removed from control plots by hand. Throughout the investigation, it was observed that only annual weeds had to be removed by hand from the control plots. No perennial weeds were observed either in control plots or in other experimental plots. One irrigation was given in 1955 season and three irrigations were given during one month of transplanting in 1956 due to lack of effective rains.

Tobacco leaves were harvested leaf-wise and were dried in the sun. Aggregate dry weight of the lamina, mid-ribs, sand leaves and bark of stems constituted the yield of *bidi* tobacco. The nicotine content of dried lamina was determined by silico-tungstic acid method as recommended by A.O.A.C. [1950]. Since there exists no standard method for evaluating *bidi* tobacco, valuation of the produce was carried out by five representative tobacco merchants. Average of this valuation was considered as probable market value of the produce of each treatment and from this, value and cash realization per acre was worked out. Leaf size and unit weight of leaf were studied from five random plants per plot.

Brinjal

A similar experiment was conducted on an irrigated crop of brinjal where normal interculturing and no-interculturing treatments were compared by Student's paired method with seven replications.

Two seedlings were transplanted per hill at a distance of 3 ft. × 3 ft. in plots of 84 ft. × 18 ft. in size, on October 5th, 1955 and September 7th, 1956.

Normal interculturing was carried out after each irrigation till the flowering stage. Brinjal fruits were picked by hand as and when ready. The number of fruits per hill and their weight were studied from seven random plants per plot.

Soil Moisture Studies

Soil moisture was determined from each experimental plot of tobacco in the year 1955-56. It was not possible in 1956-57 due to heavy rains and spread of plants. The soil samples were taken from the soil column between 3 and 15 inches from the soil surface. Per cent moisture was calculated after the soil samples were dried in an oven at 105°C. until their weights were constant.

The determination of soil moisture was first made at the end of monsoon (on the 13th October). The plots were irrigated on the 23rd October. The moisture determinations were made on the 27th October and every fortnight thereafter till the 8th December.

EXPERIMENTAL RESULTS

Tobacco

There was a considerable variation in plant stand in 1955-56 season due to heavy rains after transplanting. The yield data for the season were, therefore, adjusted by employing co-variance technique. The plant stand in 1956-57 season was normal in all the experimental plots.

The yield data, nicotine content, average value per maund and cash realisation per acre for both the years are presented in Table I.

Examination of the data presented in Table I reveals that no-interculturing treatment consistantly gave higher yield, nicotine content, average value in rupees per maund and cash realisation in rupees per acre than that in interculturing at different intervals. F test for yield and nicotine content was not significant, however, in both the years.

It will be very interesting to note that there is a corresponding reduction in yield, nicotine content, valuation and realisation in cash per acre as the number of interculturing increases.

The data for the size and thickness of the leaf of tobacco from different interculturing treatments are given in Table II.

A critical study of the data on leaf size and unit weight of the leaf indicated that there was no significant difference in these characters excepting leaf width in the year 1956-57, where it was significantly higher in no-interculturing as compared to interculturing at 5 and 10 days intervals. However, in 1956-57, interculturing seemed to decrease the ultimate size (length, width, area) and unit weight of tobacco leaf.

Brinjal

The effect of interculturing and no-interculturing on the average yield of brinjal per acre, average number of fruits per hill and average weight of brinjal in grammes for the years 1955-56 and 1956-57 is shown in Table III.

Although no significant difference was observed in yield, no-interculturing treatment consistantly yielded a heavier crop in both the years.

The results also indicate that brinjal crop showed no clear cut response to interculturing as far as number of fruits per hill was concerned. On the other hand, the treatments clearly reveal that no-interculturing significantly increased the fruit weight consistantly during both the years.

Soil Moisture Studies

The data on soil-moisture determinations made at the end of the rainy season after irrigation and every fortnight thereafter are presented in Table IV.

A critical study of soil moisture data given above clearly indicates that :

(i) no-interculturing as well as interculturing at 5-day interval had significantly higher moisture content at the end of monsoon as compared to interculturing at 10-day interval (13th October),

(ii) even after irrigation, the differences in the moisture content among the treatments were not significant (27th October),

(iii) the loss of moisture was maximum during the first fortnight after irrigation (27th October to 10th November),

(iv) a fortnight after irrigation (10th November), there was very little difference in the soil moisture content among the treatments, and

(v) though not significant in all the treatments, the loss of moisture in no-interculturing treatment was the least.

TABLE I—*Yield data, nicotine content, average value and cash realisation for the years* 1955-56 *and* 1956-57

Treatment	Total number of interculturing		Yield (lb. per acre)			Nicotine content (per cent)		Average value (Rs. per md.)		Cash realisation (Rs. per acre)	
			1955-56								
	1955-56	1956-57	Unadjusted	Adjusted	1956-57	1955-56	1956-57	1955-56	1956-57	1955-56	1956-57
A : No-interculturing	..	..	886	960	1802	7·12	6·01	84·00	68·50	980	1,501
B : Two interculturing	2	2	938	927	1704	7·03	5·82	78·40	64·50	883	1,336
C : Interculturing at 10-day interval	8	3	846	865	1686	6·78	5·97	72·00	63·00	757	1,291
D : Interculturing at 5-day interval	16	5	954	886	1669	6·61	5·94	75·20	55·00	809	1,116
F. test			Not significant			Not significant					
S. Em.			66·5	50·1	72·1	0·678	0·173				

TABLE II—*Data of size and thickness of leaf on tobacco from different interculturing treatments*

Treatment	Total number of interculturing		Length (inches)		Width (inches)		Area (square inches)		Unit weight (mg. per sq. inch)	
	1955-56	1956-57	1955-56	1956-57	1955-56	1956-57	1955-56	1956-57	1955-56	1956-57
A : No-interculturing	..	..	19·16	27·64	8·41	15·24	100·07	254·10	106·40	103·20
B : Two interculturing	2	2	19·25	26·92	8·53	14·76	103·41	243·48	104·80	101·60
C : Interculturing at 10-day interval	8	3	19·32	25·78	9·17	13·88	112·80	221·86	100·80	103·70
D : Interculturing at 5-day interval	16	5	19·33	25·90	8·91	13·91	110·35	227·64	102·20	101·80
F. Test	..	..	N.S.	N.S.	N.S.	S	N.S.	N.S.	N.S.	N.S.
L.S.D. at 5 per cent leve	..	..	..	..	..	1·16	..	..	..	..
S. Em.	..	..	0·618	0·559	0·307	0·335	7·00	10·028	3·594	1·325

S.=Significant.
N.S.=Not significant.

TABLE III—*Effect of interculturing and no-interculturing on the yield and average weight of brinjals*

Treatment	Average yield of brinjal (lb. per acre)		Average number of fruits of brinjal per hill		Average weight of brinjal fruit (gm.)	
	1955-56	1956-57	1955-56	1956-57	1955-56	1956-57
Normal interculturing	9660	7977	25	10	34·6	75·5
No-interculturing	10145	9293	24	13	37·2	85·3
Observed value of 't'	0·63	1·99	0·56	1·69	2·9	4·1
Significant or otherwise	N.S.	N.S.	N.S.	N.S.	Significant	Highly significant
L.S.D. at 5 per cent	..	..	..	..	2·2	5·9
S. Em.	563·4	466·8	1.3	1·4	0·58	1·76

TABLE IV—*Data on soil moisture determinations made after rainy season and irrigation*

Treatment	Per cent soil moisture on oven-dry basis					Loss between the 27th October and the 8th December (per cent)
	13-10-55	27-10-55	10-11-55	24-11-55	8-12-55	
A : No-interculturing	12·24	9·91	7·72	6·51	5·81	4·10
B : Two interculturing	11·72	11·48	8·97	6·99	5·18	6.30
C : Interculturing at 10-day interval	10·04	12·32	7·90	6·78	5·62	6·70
D : Interculturing at 5-day interval	12·34	11·39	8·13	6·68	5·49	5·90
F. test	Significant	..	..	..	..	Not significant
L.S.D. at 5 per cent	1·85	..	..	..	..	..
S. Em.	0·480	0·613	..	..	..	0·661

DISCUSSION

From an average of the yield during both the years of experiments, it is clear that no-interculturing gave higher outturn of tobacco by 5, 8 and 8 per cent over two interculturings and those at 5 and 10-day intervals respectively. The same was true in the case of an irrigated brinjal crop where from no-interculturing an yield 10·2 per cent higher than that from the normal practice was obtained.

The results obtained under the present investigation can probably be attributed to :

(i) The interculturing operations are likely to damage the surface feeding roots of tobacco and brinjal and as a result, the plants cannot naturally make the normal growth;

(ii) Interculturing increases evaporation from the upper layer, depriving the plants from their nutrients from the richest section of the soil;

(iii) The operations render the upper soil surface loose, liable to be washed away during heavy rains resulting in the loss of nutrients;

(iv) The plants are likely to sustain injury by the bullock's feet and hoes during interculturing; and

(v) The operations may help only in controlling the weeds.

The quality of *bidi* tobacco meant mainly for smoking is directly related to its nicotine content. This quality has been adversely affected by the increased number of interculturing. This may be accounted for the fact that the roots, the main centres of synthesising nicotine, [Dawson, 1941,1942 and 1942 a] are likely to be damaged during interculturing operations.

The produce from plots with no-interculturing was valued highest by the tobacco merchants for possessing better burning quality, higher smoking strength, better colour and thickness of the produce and naturally, the estimated value and cash realisation per acre were consistantly higher than the produce from plots with two or more interculturings.

Length, width, area and unit weight of the tobacco leaf remained more or less the same in 1955-56. However, in 1956-57 these were more, though not statistically significant.

The studies on brinjal showed that the number of fruits produced per hill had no consistant effect of interculturing, whereas the normal interculturing significantly reduced the weight of individual fruit to the extent of 7·5 to 13 per cent. Damage to roots might be the cause in lowering the weight of fruit.

The present investigations indicate that the old capillary conception of soil mulch exercising a good deal of control over conservation of soil moisture does not seem to be tenable. The results on soil-moisture studies indicated that interculturing did not conserve any more moisture than the weed-free non-intercultured plots. Nearly the same percentage of soil moisture in plots with no-interculturing and interculturing at 5-day interval may be due to the fact that the highest loss expected from frequent interculturings was compensated by more efficient weed killing.

It was interesting to note that the plots with interculturing when irrigated could absorb more moisture without conserving it even for a fortnight. No doubt, they lost it much faster than the plots with no-interculturing because of the friable nature of the soils of the intercultured plots. This is why a very little difference in soil moisture percentage in different treatments is observed a fortnight after irrigation.

This may also be explained by the facts that (i) the water table in this area is more than 60 feet. And since the capillary force is effective within a range of 10 feet only [Hilgard, 1906; Shaw and Smith, 1927] it cannot prevent further loss of water by evaporation in plots with or without interculturing, and (ii) the sandy loam soils with their open structure absorb most of the rains falling with moderate or a little higher intensity.

SUMMARY AND CONCLUSION

In sandy loam soils no-interculturing gave a consistent tendency to yield higher up to an extent of 8 per cent. [illegible] as compared to normal practice of interculturing at 10-day interval.

Nicotine content was higher with no-interculturing as compared to interculturing at different intervals.

Tobacco produced with no-interculturing was valued higher by Rs. 1 per maund [illegible] and cash realisation was Rs. 100 more per acre than that realised with interculturing at 10-day interval.

Interculturing showed either no effect or negative effect on the size and leaf weight of tobacco leaf.

Bengal yielded a larger crop with significantly heavier leaf with nearly the same number of leaves without interculturing as compared to normal interculturing.

Moisture studies with tobacco crop revealed that interculturing did not help in conserving the moisture in sandy loam soils.

It may be concluded that interculturing has either no effect or negative effect on the crops and hence it would be advantageous for the growers to [illegible] and instead adopt the practice of thorough preparatory tillage and hand weeding [illegible] the frequency of interculturing should be reduced to a minimum for weed control.

ACKNOWLEDGEMENT

The authors are thankful to Dr. M. D. Patel, Director of the Institute of Agriculture, Anand, for the suggestions made by him during the course of the investigation. They also thank Dr. M. K. Patel, former Plant Pathologist to the Government, Bombay State, Poona, for the constructive criticism in the presentation of the material.

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EVALUATION OF SOIL TESTS FOR AVAILABLE PHOSPHORUS

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(With 4 Text Figures)

Much progress has been made in developing chemical methods for assessing soil fertility. Apparently no simple form of chemical analysis can give a reliable measure of availability under all conditions. Their successful use depends to a very large extent upon careful calibration of the results of chemical tests with responses of crops to application of fertilizers on different soils. Many procedures for so called "available phosphorus" have been tried with varying success [Bray, 1945 and 1948; Das, 1926; Dyer, 1894; Hermann, 1943; Lechartier, 1884; Martin and Buchanan, 1950; McGeorge, 1947; Merkle, 1940; Morgan, 1941; Nelson and Heidel, 1950; Nelson *et al.*, 1951 and 1953; Fitts, 1956; Olsen, 1954; Spurway, 1938; Thornton, 1945 and Truog, 1930]. The various chemical extracting solutions used have varied in respect of acidity and other characteristics. While probably no single method can be applicable to all soils the diversity of the methods in use is baffling. In a few studies , comparisons have been made of a number of methods [Lawton *et al.*, 1947; Fitts *et al.*, 1956; and Thomson and Pratt, 1954] but these are very limited. Recently, the Soil Test Work Group of the National Soil Research Committee of U.S.A. has compared several different methods [Fitts *et al.*, 1956]. The $NaHCO_3$ method developed lately has been a significant contribution [Olsen, 1954].

Most of the work done in India in the direction of determination of available phosphorus has been done with the citric acid method [Dyer, 1894]. Correlations of the analytical data with crop responses are not available. The limits set by Dyer for English soils were used. A notable contribution was the development of the K_2CO_3 method [Das, 1926] for calcareous, soils but, unfortunately, this was not followed through. A country-wide programme of soil testing created the need for a more suitable method for phosphorus. This study was, therefore, initiated to evaluate, correlate and calibrate the more important methods for Indian conditions, using a wide variety of soils and the two major crops, wheat and paddy. Most of the soil tests for phosphorus were designed for arable soils. A further objective was to determine the performance of the methods under paddy soil conditions.

MATERIAL AND METHODS

The soils used in this study came from various centres where agronomic trials and soil survey were conducted in a recent country-wide soil fertility investigation programme. They represented a wide variety of soils and climates. Their moisture equivalents varied from 6·9 to 47·7 per cent, *p*H from 5·0 to 8·8, and $CaCO_3$ from nil to 6·5 per cent. Most of the soils were slightly acidic, neutral or alkaline. Surface soil samples were air dried in the shade and processed to pass through 2 mm. sieve before use in greenhouse studies on wheat and rice. The treatments were 0, 40, 80 and 160 lb. P_2O_5 per acre applied as superphosphate. A basal dose of 100 lb. N per acre, 60 lb. K_2O per acre and trace elements at suitable doses were applied. For paddy, the soils were kept flooded with 2-3 inches of standing water. Harvesting was done at the flowering stage and yield data recorded. In most of the cases the response curves indicated that the additional phosphorus increments would not give significant additional increases in yields. The per cent yield response was calculated as:

$$\frac{\text{Yield @160 lb. } P_2O_5\text{/acre} - \text{yield of control (no P)}}{\text{Yield at 160 lb. } P_2O_5\text{/acre}} \times 100$$

In experiments conducted during 1955-56, superphosphate tagged with P_{32} was used permitting available soil phosphorus as defined by 'A' value [Fried and Dean, 1952] to be determined. In a limited number of cases, samples were drawn from the field experiments conducted in cultivator's fields and for which yield data were available. Nine different extraction procedures, which included strong acids, weak acids, buffered solutions, solutions having exchangeable anions and alkaline solutions were tried in this investigation. Literature references for

the actual extraction procedures used are given in Table I. Except where otherwise stated, the phosphorus in the clear extract was estimated by the Dickman and Bray method [1940]. For water extracts the Truog and Mayer method [1929] was used. In citric acid extracts, after destruction of organic matter, phosphorus was estimated by the vanado-molybdate method [Koenig and Johnson, 1942]. The correlation coefficients, their averages and regression equations have been calculated following standard statistical procedures.

RESULTS AND DISCUSSION

Soil test values expressed in pounds P_2O_5 per acre (2×10^6 pounds) obtained by different methods have been compared against per cent yield response and 'A' values by calculation of correlation coefficients (r), and the prediction value $r^2 \times 100$, and by preparation of scatter diagrams and frequency distribution tables. Correlation coefficients between soil test values and per cent yield response are given in Tables I and II. The nature of variables in the case of soil test values and per cent yield response is such that a negative value of correlation coefficient is expected.

Correlations obtained in the case of greenhouse experiments were much better than those for the field experiments. This is to be expected in view of the large number of otherwise uncontrollable factors operating under field conditions, e.g., climate including rainfall, sampling, subsoil phosphorus, supervision, etc. The $NaHCO_3$ method appeared definitely superior in all the wheat and paddy greenhouse experiments. Highly significant correlations were obtained in almost all cases. Next in performance is a group of three methods, 0·025 N HCl+0·03 N NH_4F, 1 per cent citric acid and CO_2 which gave significant values in about half the experiments. The performance of the remaining methods was much poorer. Though the calculated values of average correlation coefficients are significant in the case of almost all methods, a better idea about the performance of the methods is possible by comparing the values of $r^2 \times 100$. The sodium bicarbonate method was best with a prediction value of 59 per cent for both wheat and paddy. The 0·025 N HCl+0·03N NH_4F, citric acid and CO_2 methods gave prediction values of 50, 49 and 45 per cent respectively for wheat and 32, 37 and 30 per cent respectively for paddy. The rest of the methods usually had still lower values. The performance of the $NaHCO_3$ method was equally good for both wheat and paddy while the other methods generally gave poorer correlation in the case of paddy as compared to wheat. The $NaHCO_3$ method was developed for arable soils but seemed to be equally applicable on flooded rice-growing soils. In the case of field experiments on wheat and paddy, $NaHCO_3$ method has shown the best relationship between soil test and per cent yield response.

Correlation coefficients for soil test values by various methods and per cent yield response have been separately calculated for the few acid soils used under wheat (4 out of 29 soils) and paddy (10 out of 49 soils). These values are also given in Table I. The $NaHCO_3$ method appears satisfactory.

Scatter of points in the diagrams suggest the possibility of a curvilinear relationship between per cent yield response and the $NaHCO_3$ soluble phosphorus (Fig. 1 and 2).

The conversion of the soil test values for both wheat and paddy to logarithms and calculation of correlation coefficients showed a significant improvement—the value increased from 0·75 to 0·89, i.e., a greater proportion of the total variance is accounted for by this curvilinear relationship. The coefficients reported earlier, therefore, expressed only the linear component of the total degree of concomitance. Curvilinear regression equations for wheat and paddy worked out to give a better description of the concomitant variation are given in Figs. 1 and 2. The constants for the regression equations representing the two crops are in good agreement which suggests that the soil-test values will represent similar ranges in soil fertility. This again suggests that the $NaHCO_3$ method is equally applicable to soils cropped under arable or submerged conditions.

Data on 'A' values were available in two experiments on wheat and two on paddy. Correlation coefficients of soil test values with 'A' values are presented in Table III.

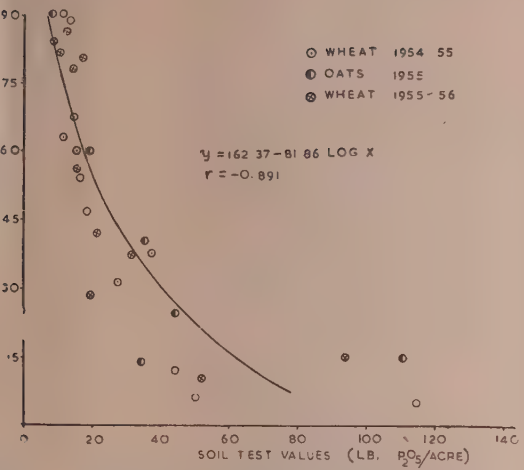

Fig. 1. Relationship between soil-test values by 0·5M $NaHCo_3$ method and per cent yield response in greenhouse experiments on wheat

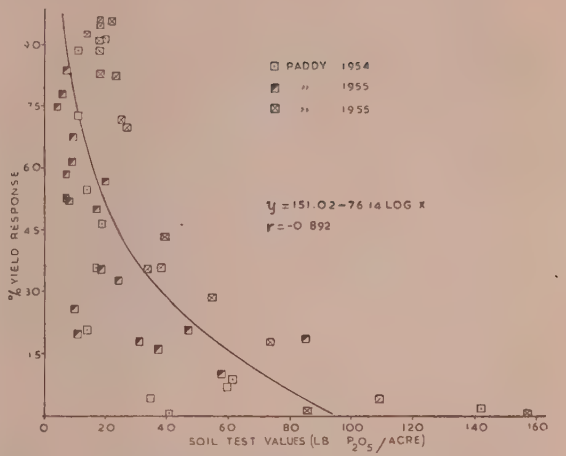

Fig. 2. Relationship between soil-test values by 0·5M $NaHCo_3$ method and per cent yield response in greenhouse experiments on paddy

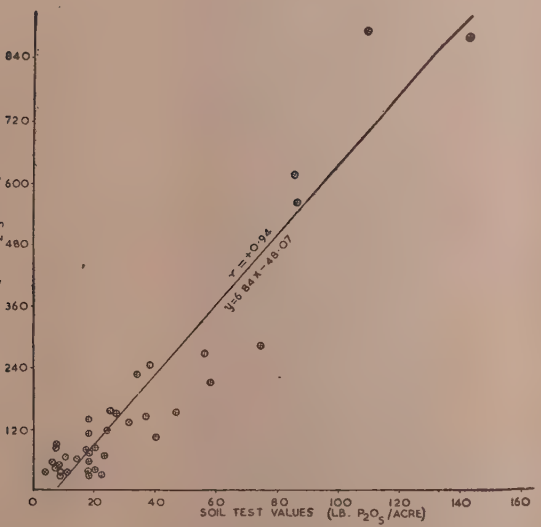

Fig. 3. Relationship between soil-test values by 0·5M $NaHCo_3$ method and 'A' values in greenhouse experiments on wheat

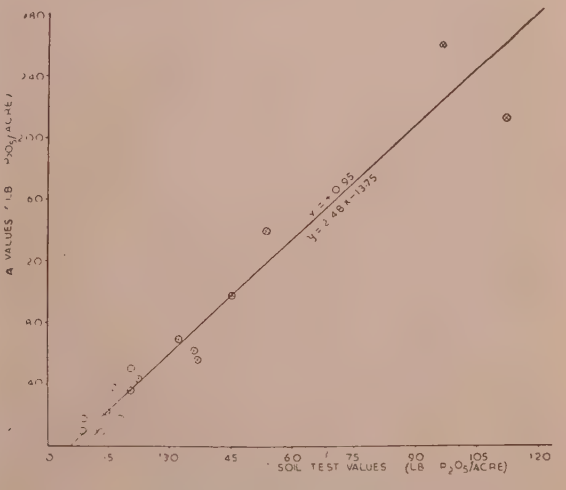

Fig. 4. Relationship between soil-test values by 0·5M $NaHCo_3$ method and 'A' values in greenhouse experiments on paddy

TABLE I—*Correlation coefficient of soil-test values for phosphorus by various methods and per cent yield response in greenhouse experiments*

Method	Wheat				Paddy				Average for wheat and paddy	Acid soils under wheat n=4	Acid soils under paddy n=10
	1954-55 n=12	1955 n=6	1955-56 n=11	Average	1954 n=11	1955 n=18	1955 n=20	Average			
0.5M $NaHCO_3$, *p*H8.5 (Olsen, 1954)	−0·767**	−0·708	−0·754**	−0·752**	−0·618*	−0·671**	−0·855**	−0·758**	−0·756**	−0·987*	−0·685*
0.13N HCl (Spurway, 1938)	−0·310	−0·767	−0·389	−0·431*	−0·290	−0·404	−0·317	−0·345*	−0·374**	−0·579	−0·638*
0.10NHCl + 0.03N NH_4F (Bray, 1948)	−0·822**	−0·529	−0·460	−0·670**	−0·299	−0·225	−0·293	−0·269**	−0·425**	−0·672	−0·818**
0.025N HCl + 0.03N NH_4F (Bray, 1945)	−0·748**	−0·673	−0·677*	−0·710**	−0·352	−0·589*	−0·439	−0·483**	−0·568**	−0·664	−0·662*
0.002N H_2SO_4, *p*H 3.0 with $(NH_4)S_2O_4$ (Truog, 1930)	−0·502	−0·712	−0·558	−0·561**	−0·327	−0·332	−0·392	−0·357*	−0·430**	+0·473	+0·156
1 per cent citric acid (Dyer, 1894)	−0·779**	−0·723	−0·564	−0·697**	−0·419	−0·639**	−0·558*	−0·565**	−0·614**	−0·603	−0·709*
CO_2 (McGeorge 1947)	−0·731**	−0·569	−0·634*	−0·672**	−0·363	−0·594**	−0·434	−0·485**	−0·554**	−0·678	−0·580
H_2O (Martin, 1950)	−0·480	−0·573	−0·594	−0·542**	−0·208	−0·318	−0·353	−0·312	−0·395**	−0·571	−0·502
Sodium acetate + acetic acid *p*H 4.8 (Morgan, 1941)	−0·285	−0·518	−0·629*	−0·473*	−0·229	−0·583*	−0·479*	−0·477**	−0·475**	−0·088	+0·294

*Significant at 5 per cent level.
**Significant at 1 per cent level.

TABLE II—*Correlation coefficient of soil-test values for phosphorus by various methods and per cent yield response in field experiments*

Method	Wheat, 1953-54 n=27	Paddy, 1954 n=17	Average for wheat and paddy
0·5M $NaHCO_3$, *p*H 8.5	−0·413*	−0·515*	−0·452**
0·13 N HCl	−0·159	−0·147	−0·155
0·10N HCl+0.03 N NH_4F	−0·049	−0·114	−0·073
0·025N HCl+0.03 N NH_4F	−0·397*	−0·219	−0·334*
0·002N H_2SO_4, *p*H 3.0 with $(NH_4)_2S_2O_4$	+0·057	−0·052	+0·017
1 per cent citric acid	−0·399*	..	..
CO_2	−0·239	..	..
H_2O	−0·154	−0·543*	−0·312
Sodium acetate + acetic acid, *p*H 4.8	−0·188	−0·186	−0·187

*Significant at 5 per cent level.
**Significant at 1 per cent level.

TABLE III—*Correlation coefficient of soil-test values for phosphorus by various methods in greenhouse experiments on wheat and paddy, and 'A' values*

Method	Wheat			Paddy		
	1955 n=6	1955-56 n=11	Average	1955 n=18	1955 n=20	Average
0.5M $NaHCO_3$, *p*H 8.5	+0·988†	+0·933†	+0·992†	+0·919†	+0·958	+0·943†
0.13N HCl	+0·208	+0·186	+0·192	−0·03	+0·08	+0·029
0.1N HCl+0.03N NH_4F	+0·562	+0·283	+0·367	−0·089	+0·045	−0·018
0.025N HCl+0.03N NH_4F	+0·413	+0·381	+0·390	+0·140	+0·103	+0·120
0.002N H_2SO_4, *p*H 3.0	+0·288	+0·359	+0·340	+0·286	+0·198	+0·239
1 per cent citric acid	+0·856*	+0·306	+0·522*	+0·207	+0·409	+0·318
CO_2	+0·027	+0·273	+0·208	+0·150	+0·093	+0·120
H_2O	+0·376	+0·412	+0·402	+0·132	+0·197	+0·167
Sodium Acetate + acetic acid	−0·027	+0·273	+0·194	+0·155	+0·181	+0·169

*Significant at 5 per cent level.
†Significant at 1 per cent level.

When the 'A' values are taken as independent measures of available phosphorus in soils, again the $NaHCO_3$ method gives a good estimate of available phosphorus for both wheat and paddy. The values of correlation coefficients are very high. A linear relationship apparently exists between these two variables. Next in performance is the citric acid method. The other methods gave still lower correlation coefficients.

Scatter diagrams for soil-test values by the $NaHCO_3$ method for both wheat and paddy and 'A' values show a linear relationship between these variables as indicated in Fig. 3 and 4.

They confirm what was observed earlier in the case of soil test-values and per cent yield response, namely, that the same ranges in the classification of soil-test values by the $NaHCO_3$ method for both wheat and paddy are suitable. In the case of the other methods, the scatter of points was much wider and no exact relationship was apparent.

A successful soil test method should enable the grouping of soils into fertility classes for suggesting fertilizer applications. The frequency distribution of samples according to per cent yield response and soil-test values by different methods is given in Table IV.

TABLE IV—*The frequency distribution of soil-test values grouped according to per cent yield response*

Method	Pounds P_2O_5 per acre	Per cent yield response on wheat. No. of samples in each group			Per cent yield response on paddy. No. of samples in each group		
		25%	26—50%	50%	25%	26—50%	50%
0·5 M $NaHCO_3$	20	0	2	14	2	4	20
	21—50	3	5	0	5	4	4
	50	5	0	0	9	1	0
0·13 N HCl	100	2	2	6	9	5	18
	100—200	1	2	5	1	0	1
	200	5	3	3	6	4	5
0·1 N HCl+0·03N NH_4F	75	0	0	3	1	2	7
	75—200	0	2	3	9	2	9
	200	8	5	8	6	5	8
0·025 N HCl+0·03 N NH_4F	20	1					
	21—50	1	1	7	2	1	18
	50	6	3	3	8	2	4
			3	4	6	6	2
0·002 N H_2SO_4, *p*H 3·0	170	2	1	9	5	4	12
	170—300	2	3	2	1	2	1
	300	4	3	3	10	3	11
1 per cent citric acid	200	1	2	7	3	2	15
	200—400	2	2	7	5	4	8
	400	5	3	0	8	3	1
CO_2	10	2	2	11	9	6	22
	11—25	1	2	3	5	1	2
	25	5	3	0	2	2	0
H_2O	0·6	0	0	0	0	0	6
	0·6	8	7	14	16	9	18
Sodium acetate+acetic acid	8	3	2	7	7	3	15
	8—25	1	1	7	7	4	9
	25	4	4	0	2	2	0

The soil samples have been separated into three groups, those showing less than 25 per cent yield increase, those from 26 to 50 per cent, and those over 50 per cent. Similarly, the values for each extractant were divided into three classes. In making these classes the authors were guided by the literature on this subject. However, in the $NaHCO_3$ method where definite relations from the presented data were possible, <20, 21–50 and >50 lb.P_2O_5 acre have been chosen as the limits.

In general, greatest response would be expected from the low classes and least response from the high classes in soil-test values. In wheat, 14 samples had $>$ 50 per cent yield response, 6 samples had$>$ between 25–50 per cent and 9 samples <25 per cent. In paddy, 24 samples had >50 per cent, 11 samples had between 25–50 per cent, and 14 samples <25 per cent. A glance on the data will show that the performance of the $NaHCO_3$ method again is the best. Less difference, however, is indicated here among extracting solutions than was shown by the correlation data.

SUMMARY

Comparative performance is reported for several of the more common rapid soils tests for phosphorus on a wide variety of Indian soils. The moisture equivalent of these soils varied from 6·9 to 47·7 per cent, *p*H from 5·0 to 8·8 and $CaCO_3$ from nil to 6·5 per cent. Highly acid soils were not used and most of the soils were slightly acidic, neutral or alkaline. In a comparatively smaller number of cases, samples from field experiments were compared. Percentage yield response and 'A' values were used for evaluating the various methods. In general, correlation of the soil-test values with yield response was much better for greenhouse studies than for the field.

The performance of the $NaHCO_3$ method was the best and most satisfactory. In almost all the cases highly significant correlations were obtained with this method. The method appeared equally applicable for soils growing paddy. The relationship between soil-test values and per cent yield response is logarithmic. The constants for the curvilinear regression equations representing the two crops are in good agreement which suggest that the soil-test values represented similar ranges in soil fertility. The prediction value on the logarithmic scale for both wheat and paddy was as high as 80 per cent. The limits for low, medium and high for both wheat and paddy were <20, 21–50, >50 lb. P_2O_5 per acre respectively.

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STUDIES ON THE COMPOSITION OF SOME CEREAL STRAWS IN KAIRA DISTRICT

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The relative importance of the various cereal straws as fodders for the cattle in the Kaira district can be seen from their quantity produced per year as given below :

Name of fodder	Botanical name	Quantity in thousand tons	Approximate percentage
Bajri straw	*Pennisetum typhoideum*	344	52·7
Paddy straw	*Oryza sativa*	83	12·7
Jowar straw	*Andropogon sorghum*	68	10·4
Kodra straw	*Paspalum scrobiculatum*	35	5·4
Wheat straw	*Triticum sativum*	22·5	3·4
Bavto straw	*Eleusine coracana*	21	3·2
Maize straw	*Zea mays*	19	2·9
Tur gotar (tender stems, leaves and pods)	*Cajanus indicus*	16	2·4
Groundnut *gotar*	*Arachis hypogea*	22·5	3·4
Other pulse *gotars*		22	3·4
	Total	653	99·9

The statement shows that out of the total quantity of dry fodder available, *bajri* straw constitutes more than 50 per cent of the bulk, while paddy straw which comes next is produced to the extent of only 12·7 per cent. *Bajri* is grown all over the district in the *kharif* and summer seasons while *kodra*, which is an inferior millet is grown only in the *kharif* season. As far as the crop of paddy is concerned, two varieties, viz., early and late are grown in the *kharif* season.

A review of the available literature cited in a previous paper on *jowar* fodder by Patel and Shah [1956] reveals that the changes in the composition of *bajri*, paddy and *kodra* fodders with growth have not been studied so far. Hence, samples at different stages of maturity have been collected and analysed, although they are used as fodders for cattle only in the mature condition. The straws of different seasons, years and varieties have also been compared.

EXPERIMENTAL PROCEDURE

Samples of the fodder at different stages of growth were collected from four representative villages in the area within about 12 miles radius from Anand. Each village was divided into four blocks and samples were taken from several places in each block. All the material from the four blocks was mixed and a composite sample was taken to represent the village. The samples were chopped and milled into powder before analysis.

Samples from each village were analysed separately and the averages of four such results are given in the following Tables. A.O.A.C. [1950] methods of analysis were followed.

RESULTS AND DISCUSSION

Bajri fodder

In Table I is given the average composition of summer *bajri* fodder at different stages of maturity together with the results of statistical analysis.

TABLE I—*Composition of summer* bajri *fodder* (1953)
(Average of four results)

Stage	Crude protein	Ether extract	N.F.E.	Crude fibre	P_2O_5	CaO
Young	13·04	2·48	45·01	25·56	0·88	0 91
Dough	7·65	1·88	43·40	36·07	1·03	0·72
Straw	3·24	1·57	49·20	36·16	0·71	0·64
F Value :						
Villages	0·09	1·24	1·26	1·13	1·21	0·20
Stages	44·03**	10·90**	1·82	9·71*	5·38*	1·44
L.S.D. at 5 per cent for stages	2·56	0·48	7·68	6·75	0·24	0.40

* Significant at 5 per cent level.
**Significant at 1 per cent level.

From Table I it can be seen that the differences between the samples from different villages are not significant. Crude protein and ether extract contents are found to decrease with maturity while the crude fibre increases from young to dough stage and remains unchanged. The phosphate content is maximum in the dough stage and is significantly lower in either the young or the mature stage. This differs from the continuously decreasing trend observed by Patel and Shah [1956-57] in the case of *jowar* and wheat fodders. The changes in N.F.E. and calcium with growth are not found to be significant.

The average composition of *kharif bajri* fodder at different stages of growth is given in Table II along with the results of the statistical analysis.

TABLE II—*Composition of* kharif bajri *fodder* (1953)
(Average of four results)

Stage	Crude protein	Ether extract	N.F.E.	Crude fibre	P_2O_5	CaO
Young	12·84	2·72	42·03	23·18	1·28	1·07
Dough	4·26	1·05	45·77	38·80	0·70	0·62
Straw	3·45	0·90	40·80	45·50	0·88	0·32
F. Value:						
Villages	3·00	0·19	0·21	0·38	13·68**	7·89*
Stages	83·28**	13·22**	1·50	29·21**	24·32**	44·60**
L.S.D. at 5 per cent for stages	1·87	0·97	7·68	7·34	0·21	0·10

*Significant at 5 per cent level.
**Significant at 1 per cent level.

The data in Table II show the same trend in crude protein and ether extract as observed in the case of summer *bajri* fodder, while there is a continuous increase in crude fibre content. The phosphate content decreases from young to dough stage and then increases slightly in the mature condition, while a continuously decreasing trend is observed in calcium content. It is remarkable that the differences in the mineral contents of the fodder from different villages are significant. This may be due to the variations in the mineral contents of the soil or in the manurial practices prevalent in different villages.

A comparison of summer and *kharif bajri* straws is made in Table III.

TABLE III—*Comparison of summer and* kharif bajri *straw* (1953)

(Average of four results)

Season	Crude protein		Ether Extract		N.F.E.		Crude fibre		P_2O_5		CaO	
	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.
Summer	3·24	0·65	1·57	0·12	44·20	1·11	36·16	1·49	0·71	0·07	0·64	0·10
Khorif	3·45	0·45	0·90	0·15	40·48	1·66	45·50	1·66	0·88	0·03	0·32	0·06
't' value	0·26		3·38*		4·38**		4·19**		0·94		2·88**	

* Significant at 5 per cent level.

** Significant at 1 per cent level.

It can be observed from Table III that the summer straw is richer in ether extract N.F.E. and calcium contents and is less fibrous than the *kharif* straw. The excess of crude fibre content in the *kharif* samples is similar to that observed by Patel and Shah [1957] in the irrigated varieties of wheat straw as compared to non-irrigated "Niphad" wheat straw.

Kharif bajri straws of two years have been compared in Table IV.

TABLE IV—*Comparison of* kharif bajri *straws of two years*

(Average of four results)

Year	Crude protein		Ether extract		N.F.E.		Crude fibre		P_2O_5		CaO	
	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.
1952	2·42	0·36	0·91	0·12	44·22	0·87	44·82	1·18	0·72	0·07	0·62	0·14
1953	3·45	0·45	0·90	0·15	40·48	1·66	45·50	1·66	0·88	0·16	0·32	0·06
't' value	1·81		0·051		2·00		0·43		0·89		1·96	

The data in Table IV do not reveal any significant differences between the samples of 1952 and 1953.

Summer *bajri* straw of 1953 is compared with that of 1954 in Table V.

TABLE V—*Comparison of summer* bajri *straw of two years*

(Average of four results)

Year	Crude protein		Ether extract		N.F.E.		Crude fibre		P_2O_5		CaO	
	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.
1953	3·24	0·65	1·57	0·39	49·20	1·11	36·16	1·49	0·71	0·07	0·64	0·10
1954	2·74	0·40	1·19	0·06	43·70	1·51	42·49	2·38	0·58	0·08	0·37	0·04
't value'	0·66		2·92*		2·93*		2·25		1·24		2·62*	

* Significant at 5 per cent level.

Table V shows that ether extract, N.F.E. and calcium contents in the samples of 1954 are less than those in the samples of 1953. As was observed by Patel and Shah [1957] in the case of irrigated 'Niphad' wheat straw as compared to the non-irrigated variety, the lower mineral contents in the straw of 1954 may be attributed to heavier rainfall (42 inches) in that year as compared to that in the year 1953 (29 inches). The difference in crude fibre approaches significance and it may be said that the fodder of 1954 is more fibrous. This further confirms the correlation suggested while discussing the results in Table III.

Paddy fodder

The average composition of paddy fodder of the early variety at different stages of growth is given in Table VI together with the results of statistical analysis.

TABLE VI—*Composition of paddy fodder* (1953)

(Average of four results)

Stage	Crude protein	Ether extract	N.F.E.	Crude fibre	P_2O_5	CaO
Young	7·02	1·78	46·11	27·07	0·58	0·42
Dough	5·75	2·30	44·04	29·49	0·64	0·44
Straw	2·80	2·16	41·44	33·22	0·36	0·35
F Value :						
Villages	3·06	0·84	0·27	0·78	0·21	4·92*
Stages	5·08*	2·54	3·93	6·75*	2·59	1·50
L.S.D. at 5 per cent for stages	3·32	0·55	4·08	4·12	0·32	0·14

* Significant at 5 per cent level.

Table VI shows that as observed by Patel and Shah[1956-57] in the case of *jowar* and wheat fodder, crude protein decreases with the maturity, the corresponding F value approaching significance. N.F.E. also decreases as the plant grows. Ether extract in the young stage is low and increases by about 25 per cent in the dough stage and remains constant even in the straw. N.F.E. content is higher in the young stage as compared to that in the other stages. This may

be attributed to the gradual transfer of the nutrient to the grains. Crude fibre content increases with maturity. Phosphate content is found to decrease but the variation in calcium is little and irregular. These observations, however, are not statistically significant. Also, there is no significant difference between samples from different villages except that the samples from one of the villages are poorer in calcium than those from the other three villages.

The composition of the straw of early and late varieties of paddy is given in Table VII.

TABLE VII—*Comparison of early and late varieties of paddy straw* (1954)
(Average of four results)

Variety	Crude protein		Ether extract		N.F.E.		Crude fibre		P_2O_5		CaO	
	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.
Early	3·18	0·51	1·19	0·09	41·44	0·38	34·01	0·23	0·15	0·01	0·32	0·03
Late	2·61	0·04	1·21	0·09	40·74	0·33	33·25	0·65	0·20	0·03	0·28	0·03
't' value	1·12		0·20		1·40		1·10		1·44		0·69	

Table VII shows that there is no significant variation between the straws of early and late varieties of paddy.

Samples of paddy straw of early variety collected during 1952, 1953 and 1954 have been compared in Table VIII.

TABLE VIII—*Comparison of paddy straw of an early variety of three years*
(Average of four results)

Year	Crude protein	Ether extract	N.F.E.	Crude fibre	P_2O_5	CaO
1952	4·40	1·94	44·70	32·10	0·61	0·53
1953	2·80	2·16	41·44	33·22	0·36	0·35
1954	3·18	1·19	41·45	34·01	0·15	0·32
F Value :						
for years	3·10	5·74*	2·24	0·88	5·34*	1·98
L.S.D. at 5 per cent for years	1·63	0·74	4·32	3·53	0·35	0·28

* Significant at 5 per cent level.

The data in Table VIII reveal that the ether extract in the straw produced in the year 1954 is significantly lower than that in the straw produced in 1952 and 1953. The phosphate content in the former is also significantly less than that in the straw produced in 1952. On the whole it, may be pointed out that the fodder produced in 1952 is richer in the proximate constituents and minerals as compared to the straws produced in 1953 and 1954. The lower mineral contents of the latter may be attributed to heavier rainfall in 1953 (29 inches) and 1954 (42 inches) than in 1952 (16 inches). This observation is similar to that made in the case of *jowar* and wheat fodders.

Kodra **fodder** (*Paspalum scrobiculatum*)

In Table IX are presented the average results of analysis of *Kodra* fodder at different stages of growth along with the results of statistical analysis.

TABLE IX—*Composition of* Kodra *fodder* (1953)

(Average of four results)

Stage	Crude protein	Ether extract	N.F.E.	Crude fibre	P_2O_5	CaO
Flag leaf	6·62	1·16	43·80	36·48	0·70	0·52
Dough	5·07	1·43	46·76	36·66	0·59	0·42
Straw	3·89	1·70	45·62	35·60	0·49	0·46
F Value:						
Villages	0·28	0·85	2·42	2·52	3·80	0·66
Stages	10·47*	11·11**	2·57	0·15	6·86*	3·06
L.S.D. at 5 per cent for stages	1·45	0·28	3·22	5·09	0·14	0·10

* Significant at 5 per cent level.
** Significant at 1 per cent level.

From Table IX it can be seen that the crude protein and phosphate contents decrease as the plant matures and ether extract increases. Similar trend in the crude protein and phosphate contents has been observed in fodders of summer and *kharif bajri*, summer 'Sundhia' *jowar* (*Andropogon sorghum*), irrigated and non-irrigated 'Niphad' wheat and 'Pusa' wheat [Patel and Shah, 1956-57]. However, the ether extract content has been found to decrease with maturity in summer and *kharif bajri* and 'Pusa' wheat fodders.

Kodra straw of 1952 is compared with that of 1953 in Table X.

TABLE X—*Comparison of* Kodra *straw of two years*

(Average of four results)

Year	Crude protein		Ether extract		N.F.E.		Crude fibre		P_2O_5		CaO	
	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.	AV.	S.E.
1952	3·81	0·44	1·33	0·14	49·30	1·17	33·83	1·17	0·78	0·17	0·92	0·14
1953	3·89	0·24	1·70	0·05	45·62	0·71	35·60	1·14	0·49	0·05	0·46	0·04
't' value	0·29		2·47*		2·69*		1·08		1·61		3·06	

* Significant at 5 per cent level.

Table X shows that the straw of 1953 is richer in ether extract and poorer in N.F.E. and calcium than that of 1952. The difference in phosphate content, though statistically not significant, is quite appreciable. The lower mineral contents in the fodder of 1953 as compared to those in the fodder of 1952 may be attributed to the heavier rainfall (29 inches) in the former year than in the latter (16 inches). A similar observation has been made in the case of *jowar* wheat, paddy and *bajri* fodders.

SUMMARY

Samples of fodders of summer and *kharif bajri* (*Pennisetum typhoideum*), early and late paddy and *Kodra* (*Paspalam scrobiculatum*) were collected at different stages of maturity from four villages selected at random and were analysed with a view to study the change in composition with growth. The straws of different seasons, years and varieties have also been compared.

In almost all the fodders crude protein and ether extract decrease with maturity while crude fibre increases. Phosphate tends to decrease as the plant grows but the variations in calcium content are irregular.

A comparison between summer and *kharif bajri* straw reveals that the latter is more fibrous and poorer in calcium. The summer *bajri* straw is richer in ether extract and N.F.E. also.

When the straws of different crops collected in 1952, 1953 and 1954 are compared, it is found that the samples collected in 1952 were richer in minerals and less fibrous than those collected in 1953 and 1954. It may be attributed to the heavier rainfall in the latter two years.

Between the straws of early and late varieties of paddy there are no significant differences.

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THIAMINE CONTENT OF CEREALS AND PULSES

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(With 2 Text Figures)

Thiamine has been estimated in a number of foodstuffs including wheat grains by the thiochrome method [Jenson, 1936 ; Hennessy and Cereccdo, 1939 ; Ahmed *et al.*, 1948a; Ahmed *et al.*, 1948b; Report of the Aneurine Panel of Sub-committee, 1951; Hashmi *et al.* 1954; Banerjee *et al.*, 1954 ; Chitre *et al.*, 1955 ; Obnesorge and Rogers, 1956]. This method has been found to be satisfactory and is being widely used for the estimation of this vitamin. The present study describes its estimation in certain Indian wheats and pulses by the microbiological method carried out with the object of finding out a simpler and easy test for which no expensive equipment like fluorimeter is needed.

MATERIAL AND METHODS

The samples of wheat and pulses analysed here were grown under uniform conditions at New Delhi as well as Pusa (Bihar).

Method of assay : The microbiological method of Sarett and Cheldelin [1944] was followed for this purpose. Thiamine was extracted according to the recommended procedure [György, 1950]. A representative portion of the sample was hydrolysed in a steam bath for half an hour with 50 cc. N 10 H_2SO_4 and the *p*H adjusted to 4·0=4·5 with 2·5 M sodium acetate. 1 cc. of 10 per cent enzyme solution (Takadiastase and Papain) was added and kept overnight in the incubator at 37°C. The digested sample was neutralised and the *p*H adjusted to 6·5. Suitable volume was made up and filtered and finally assayed with *Lactobac'llus fermenti* 36.

Alkali treated peptone : The alkali treated peptone for the basal medium was prepared as follows:

40g. of Bacto-peptone and 20g. of NaOH were dissolved separately in 250 cc. water each and mixed thoroughly. The solution was kept in steam bath for one hour, cooled, and 11·6 gm. of sodium acetate (CH_3COONa, $3H_2O$) was added. The peptone solution was neutralised with glacial acetic acid, volume was made up to 400 cc. and kept in the cold.

Tubes were sterilized for 20 minutes in a steam bath. Growth of the bacteria was measured by urbidity as well as by titration after 18 hours' period of incubation at 37°C. The turbidity was measured in a Klett-summerson Photoelectric Colorimeter with the use of green filter 54.

The thiochrome method followed here was as given in U.S. Pharmacopoeia XIII. For this purpose, thiamine was extracted in the same way as done in the case of microbiological assay. After the enzymatic digestion, the volume was made up, filtered and passed through activated Decalso for absorption. Thiamine was eluted from the Decalso with hot acid KCl, oxidised to thiochrome with potassium ferricyanide. Fluorescence was measured in a Klett-Fluorimeter.

RESULTS AND DISCUSSION

The results of the thiamine content of a few varieties of wheat obtained by microbiological as well as by thiochrome method are given in Table I.

The figures given in Table I, indicate that the results obtained by the thiochrome method agree well with those obtained by the microbiological assay done either by titration or by measuring the turbidity. Hoff-Jorgensen and Hansen [1955] have also reported close agreement between the microbiological and the thiochrome method.

The data were subjected to statistical analysis (Table II).

TABLE I—*Thiamine content of wheat*

Wheat	Microbiological method		Thiochrome method
	Titration µg/g.	Turbidity µg/g.	µg/g.
NP 4	4·50	4·16	4·57
NP 125	4·62	4·34	4·57
NP 718	4·42	4·22	4·13
NP 737	4·78	4·38	4·00
NP 770	4·69	4·22	5·00
NP 775	4·69	4·61	4·03

TABLE II—*Statistical analysis*

	Methods	Variety
SE_m	±0·163	±0·113
C. D. at 5 per cent	0·5135	0·356
C. D. at 1 per cent	0·7304	0·5063
'F' test	Not significant	Not significant

The results of the three methods do not appear to differ significantly. The six different varieties of wheat studied do not significantly differ in their content of thiamine.

The standard curves obtained by titration as well as by turbidity are shown in Figs. 1 and 2.

It was then thought to be of interest to ascertain the reproducibility of results obtained by the microbiological method and the data are presented in Table III.

TABLE III—*Reproducibility of the results*

Samples	Thiamine content µg/g.			
	Titration		Turbidity	
	1	2	1	2
C. 591	4·60	4·85	4·54	4·60
NP 12	5·40	5·15	5·35	5·85
NP 111	4·60	4·73	4·80	5·27
NP 165	5·60	5·05	5·20	4·70

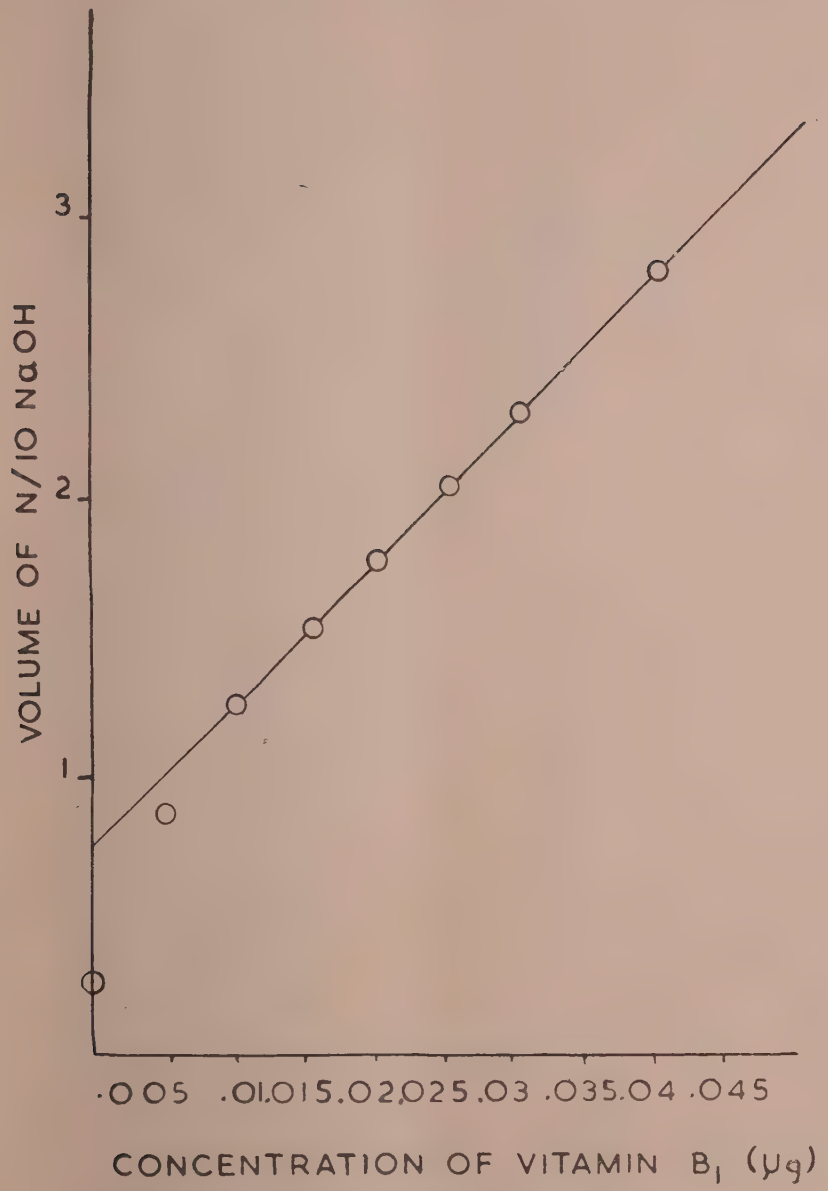

Fig. 1—Standard Curve for Thiamine Titration

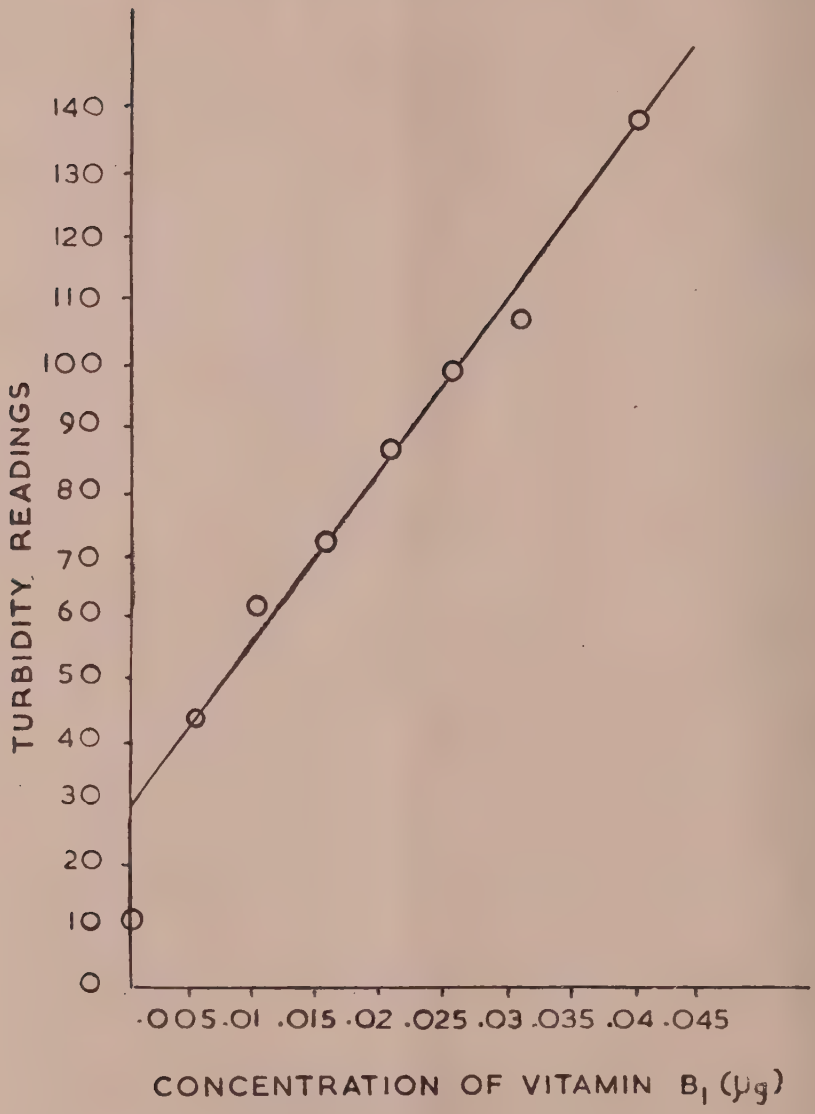

Fig. 2—Standard Curve for Thiamine Turbidity

The data of Table III indicate that the results obtained by titration agreed fairly well with those obtained by measuring turbidity.

The data of Table III were also subjected to statistical analysis (Table IV).

It is found that the values of the titration and the turbidity methods do not differ significantly. But the four varieties of wheat studied here have shown significant differences among themselves. It also appears that NP 12 and NP 165 are superior to NP 111 and C 591.

TABLE IV—*Statistical analysis*

	Methods	Variety
SE_m	±0·097	±0·137
C. D. at 5 per cent	0·2963	0·4184
C. D. at 1 per cent	0·4130	0·5835
'F' test	Not significant	Significant at 1 per cent

Recovery of thiamine by the microbiological method as estimated by titration was then studied and the results are given in Table V.

TABLE V—*Recovery of thiamine by titrations*

Total content obtained	Sample content obtained	Recovered	Added	Percentage recovery
3·33	1·38	1·95	2·0	97·5
5·26	3·36	1·90	2·0	95·0
4·37	2·37	2·0	2·0	100·0

Mean—97·5 per cent.

The recovery of thiamine by this method appears to be quite satisfactory.

In view of the simplicity of the titration method, a few varieties of wheat and pulses were analysed for this vitamin by this method. The results are given in Tables VI and VII.

The figures for wheat samples show that thiamine varies from 4·14 to 5·15 μg/g. in some of the important Indian wheats. Ahmed *et al.* [1948] and Hashmi *et al.* [1954] reported a variation of 3·55 to 5·83 μg/g. and 3·6 to 4·3 μg/g. respectively, while Chitre *et al.* [1955] found the thiamine content to be ranging from 2·87 to 4·75 μg/g.

No correlation has been found to exist between the protein and the thiamine content of the wheat grain.

TABLE VI—*Thiamine content of wheat*

Samples	Thiamine content µg/g.	Protein per cent*
K 13	4·14	9·29
C 518	4·62	9·29
C 591	4·85	9·97
NP 760	4·77	11·69
NP 12	5·15	10·38
NP 52	4·40	11·11
NP 111	4·73	10·15
NP 165	5·05	10·72
NP 710	4·65	11·40

* Figures taken from Das *et al.* [1954].

TABLE VII—*Thiamine content of pulses*

Pulses		Thiamine content of two successive crops µg/g.	
Common name	Botanical name	1953	1955
Urid NP4	*Phaseolus mungo* L.	4·13	3·75
Urid NP14	*Phaseolus mungo* L.	2·41	3·07
Rahar NP15	*Cajanus cajan* (L.) Millsp.	3·36	6·82
Rahar NP80	*Cajanus cajan* (L.) Millsp.	6·66	8·62
Lentil NP11	*Lens culinaris* Medic.	4·26	3·94
Lentil NPH1	*Lens culinaris* Medic.	1·38	3·06
Mung T1	*Phaseolus aureus* Roxb.	5·54	3·72
Mung NP23	*Phaseolus aureus* Roxb.	..	3·75
Gram NP53	*Cicer arietinum* L.	..	3·95
Gram NP58	*Cicer arietinum* L.	..	3·36
Pea NP17	*Pisum sativum* L.	..	3·99
Pea NP29	*Pisum sativum* L.	..	5·00

Pulses analysed here have been found to differ considerably in their thiamine content ranging from 1·38 µg/g. to 6·66 µg/g. in the first year's crop and from 3·06 µg/g. to 8·62 µg/g. in that of the 2nd year. The figure for *Rahar* has been very high in both the years. There also appears to be some variation in different strains of the same pulse as in the case of *Rahar*

NP15 and NP80, Pea NP17 and NP29. When the thiamine content of the two successive year's crop are compared, there appears to be some seasonal variation in the case of certain pulses. This is more prominent in the case of *Rahar* NP15 and NP80, lentil H_1 and *Mung* T_1. Ahmed *et al.* [1948] reported the thiamine content of pulses to be varying from 2·80 to 4·97 μg/g. while Reddy and Giri [1949] found a variation of 3·3 to 4·7 μg/g. Hashmi *et al.* [1954] and Chitre *et al.* [1955] found the thiamine content of different pulses to be between 0·80 to 3·06 μg/g. and 0·80 to 4·89 μg/g. respectively.

SUMMARY

1. A simple microbiological method for the estimation of thiamine in wheat and pulses has been described. The results of this method are in good agreement with those of the thiochrome method.

2. It is found that the titration and the turbidity methods gave similar results. The quantity of thiamine determined by the titration method is reproducible and the recovery appears to be quite satisfactory.

3. Different varieties of wheat and pure strains of pulses have been analysed for their thiamine content by the microbiological method by titrating the acidity formed.

4. Some of the pulses analysed here show large variation in their content of thiamine while the variation is much smaller in the case of wheat. In some cases, there appears to be strain variation in the content of thiamine. Two successive years' crops of pulses have also shown seasonal variations in their content of this vitamin.

5. No correlation has been found to exist between the protein and the thiamine content of the wheat grain.

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INFLUENCE OF MANURING ON THE QUALITY OF PASTURE GRASSES

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Very little information is available on the mineral nutrition or requirement of pasture grasses in this country. Even in Europe and the United States, this knowledge was lacking till the second or third decade of the present century. But today fertilizing the forages has assumed the form of science in those countries and large amount of fertilizers are used according to the needs of the crop and the ability of the soil to supply nutrients.

It is well known that unlike legumes, grasses cannot fix any of the nitrogen needed to build protein. Grasses to be rich in protein and to give high yields require large amounts of nitrogen in the soil. Besides nitrogen, phosphorus and potassium are also required for luxuriant growth of grass of high quality. The amount and availability of plant nutrients in the soil influence the quantity of protein and minerals found in the grass. Manuring of a soil with an element which is deficient in the soil is expected to have a favourable effect according to Orr [1929]. Similar results were obtained by Bal and Athwale [1935], Bal [1939-40] and Anwar Ullah [1939-40].

Fagon [1928] found that calcium and phosphorus contents of grass increased when fertilized with basic slag.

The application of nitrogenous fertilizers alone and in combination with other minerals was found to increase the dry matter yield and protein content by Chatterjee [1936-37]. Studies on fodder maize by Mukherji and Agarwal [1942] gave similar results, *i.e.*, fertilization with ammonium sulphate giving the highest yield.

Anwar Ullah [1939-40] did not find any difference in the composition of samples of barley straw and paddy straw, obtained from plots treated with ammonium sulphate and super phosphate. The yield and nitrogen content of wheat straw were found to increase on manuring with nitrogen but the response varied with the nature of the season and different from place to place.

Since there is only limited amount of uncultivated natural fodder available in the country and the quality of most of the Indian dry roughages is very low; and as it is known that pasture grass is an important source of calcium and phosphorus in livestock feeding, it was thought necessary to assess the amount of these materials in the pasture grasses and also the factors that influence their content.

With the above objective in view, experiments were laid out in plots during the years 1937-1941, both in the Livestock Research Station, Hosur, and the Animal Nutrition Shed, Coimbatore. These experiments formed part of the programme of research under the Animal Nutrition Research Scheme financed by the Indian (then Imperial) Council of Agricultural Research during the years 1935 to 1943.

EXPERIMENTAL METHODS

Chemical composition of Spear grass with different manures

Spear grass (*Heteropogon contortus* Beaure) was grown in plots under different manurial treatments for two years from 1937-1939 at the Livestock Research Station, Hosur, and cut and made into hay. The samples were analysed periodically for about two years for ash, silica, nitrogen, phosphoric acid, calcium oxide and potash.

Manurial Treatments

1. Farmyard manure at 10 carts/acre (control)
2. Basic slag at 4 cwt./acre + farmyard manure as in 1
3. Lime 4 cwt./acre + farmyard manure as in 1.

Size of Plot (one cent)

Each treatment was replicated six times. Composite samples for each treatment was analysed at three stages of growth, namely, (i) early growth stage, (ii) flowering stage and (iii) ripe stage (harvesting time).

TABLE I—*Composition of Spear grass hay grown under different manurial treatments (Results on dry matter basis)*

Heads of analysis		Farmyard manure at 10 carts per acre			Basic slag 4 cut plus farmyard manure at 10 carts per acre			Lime 4 cwt. plus farmyard manure 10 carts per acre		
Stage of cutting		P.F	F	H	P.F	F	H	P.F	F	H
Ash	Y1	12·30	10·69	8·32	12·26	10·35	8·82	11·44	10·22	8·28
	Y2	10·95	9·69	10·69	11·32	9·27	10·00	10·95	9·69	10·69
Insolubles	Y1	8·01	5·45	5·57	7·75	5·89	5·84	6·67	6·49	5·58
	Y2	7·03	6·28	8·16	7·56	5·69	7·50	7·03	6·28	8·16
Solubles	Y1	4·29	5·24	2·75	4·51	4·46	2·98	4·77	3·73	1·70
	Y2	3·92	3·41	2·53	3·76	3·78	2·50	3·92	3·41	2·53
Nitrogen	Y1	1·12	0·87	0·65	0·94	0·86	0·63	1·17	0·87	0·61
	Y2	0·88	0·77	0·50	0·85	0·77	0·56	0·88	0·77	0·50
Lime (CaO)	Y1	0·63	0·53	0·42	0·72	0·60	0·42	0·61	0·62	0·39
	Y2	0·66	0·44	0·42	0·69	0·45	0·44	0·66	0·44	0·42
Phosphoric acid (P_2O_5)	Y1	0·48	0·40	0·40	0·63	0·54	0·69	0·61	0·47	0·53
	Y2	0·63	0·48	0·51	0·52	0·39	0·40	0·48	0·40	0·40
Potash (K_2O)	Y1	1·69	1·68	1·10	1·62	1·92	1·13	1·91	1·66	1·07
	Y2	1·43	1·55	0·93	1·36	1·66	1·92	1·43	1·55	1·93

P.F.—pre-flowering. F—flowering. H—harvest. Y1—first year. Y2—second year.

RESULTS

The chemical compositions of spear grass hay was found by the usual methods of analysis (Table I). As only the composite samples of grasses were analysed the statistical analysis of data could not account for differences due to replications. The statistical analysis (Table II) however, revealed the following:

(1) There was a definite fall in the lime content as the crop advanced in age, while this was not true with reference to other minerals;

(2) In regard to phosphoric acid the pre-flowering stage was the most nutritious, the harvest in stage being slightly superior to the flowering stage, though not significantly different from it;

(3) With reference to protein, though there was a fall due to the age of the crop, the difference did not appear to be significant;

(4) The other general findings were that the application of basic slag or lime had no appreciable effect on the mineral composition of the herbage.

TABLE II—*Statistical summary of the chemical composition of Spear grass hay grown under different manurial treatments*

Mineral	Factors	Mean per cent mineral for each class of factor			Critical difference
	Treatment	L	F.Y.M.	B.S.	
Protein		0·799	0·798	0·768	0·500
	Stages	P.F.	F	H	
		0·974	0·921	0·571	0·500
	Treatment	B.S.	L	F.Y.M.	
Lime (CaO)		0·553	0·532	0·518	0·100
	Stages	P.F.	F	H	
		0·668	0·520	0.413	0·100
	Treatment	B.S.	F.Y.M.	L.	
Phosphoric acid (P_2O_5)		0·527	0·484	0·478	0·057
	Stages	P.F.	H	F.	
		0·561	0·482	0·452	0·057

L—lime. F.Y.M.—farm yard manure. B.S.—basic slag. P.F.—pre flowering F—flowering H—harvest.

Chemical composition of Kolukattai and Rhodes grasses manured with different manures

The experimental plots were laid out in the fields adjoining the Animal Nutrition Shed at Coimbatore. There were three treatments as given below :

1. No manure,
2. Cattle manure to give 150 lb. nitrogen per acre, and
3. Ammonium sulphate to provide nitrogen as in Treatment 2.

Size of Plot (one cent)

There were two series. In one series Kolukattai grass (*Cenchrus ciliaris* L.) and in the other Rhodes grass (*Chloris gayana* Kunth) were grown. The trials were run for four years from 1939-1940 to 1942-43. Samples were collected at three stages, namely, pre-flowering, flowering and harvest, and analysed for their chemical composition. A second crop of grass was also

TABLE III—*Composition of Kolukattai grass and Rhodes grass grown under different manurial treatments*—1939-1940

		KOLUKATTAI GRASS									RHODES GRASS								
		Control			Cattle manure			Ammonium sulphate			Control			Cattle manure			Ammonium sulphate		
		P.F	F	H	P.F	F	H	P.F	F	H	P.F	F	H	P.F	F	F	P.F	F	H
Ash	Y1	20·06	15·72	24·58	17·66	14·71	13·75	18·21	14·75	12·84	14·21	13·37	12·93	14·08	11·81	10·98	17·42	12·69	11·93
	Y2	17·04	29·40	18·41	15·32	24·58	13·71	14·57	26·24	17·28	13·57	15·30	12·34	14·10	14·70	13·41	13·37	11·76	11·80
Silica	Y1	8·87	9·43	10·54	9·02	9·04	8·57	7·14	7·31	6·37	6·68	6·82	8·14	7·50	6·68	6·75	6·45	5·45	5·77
	Y2	8·45	21·70	13·56	7·52	12·72	7·33	5·91	18·20	8·94	4·22	9·51	4·30	4·64	7·06	5·38	3·93	5·28	5·30
Solubles	Y1	11·19	6·29	14·04	8·64	5·67	5·18	9·07	7·34	6·47	7·53	6·55	4·79	6·58	5·13	4·23	10·97	7·24	6·16
	Y2	6·85	7·70	4·85	7·80	12·86	6·38	8·66	8·04	8·34	9·35	5·79	8·04	9·46	7·64	8·03	9·44	6·48	6·50
Nitrogen	Y1	2·78	1·71	1·57	1·78	1·22	1·06	2·54	1·71	1·54	2·54	1·68	1·46	1·38	1·01	0·78	2·37	1·47	1·42
	Y2	2·88	1·88	2·21	1·85	1·78	1·69	2·80	2·23	2·29	2·40	2·05	1·71	1·78	2·21	1·56	2·73	2·45	2·05
Lime (CaO)	Y1	0·78	0·62	0·79	0·56	0·47	0·50	0·61	0·50	0·48	0·82	0·68	0·65	0·57	0·52	0·51	0·97	0·58	0·63
	Y2	0·85	0·99	0·75	0·67	0·62	0·57	0·65	0·84	0·61	0·67	0·51	0·57	0·61	0·60	0·58	0·73	0·61	0·55
Phosphoric acid (P_2O_5)	Y1	0·43	0·40	1·16	0·56	0·48	0·78	0·52	0·64	1·02	0·43	0·45	0·54	0·59	0·43	0·72	0·64	0·61	0·75
	Y2	0·31	0·21	0·26	0·29	0·23	0·22	0·37	0·29	0·32	0·32	0·29	0·28	0·33	0·33	0·34	0·30	0·31	0·25
Potash	Y1	1·69	1·29	0·96	1·89	1·33	0·97	1·93	1·34	1·09	1·79	1·35	1·21	1·63	1·24	0·89	2·32	1·17	0·96
	Y2	1·31	0·82	1·23	1·17	0·93	1·04	1·19	0·92	1·26	1·34	9·98	1·16	1·39	1·20	1·25	1·31	1·06	1·16
Sulphur	Y1	0·33	0·21	0·26	0·25	0·20	0·22	0·29	0·21	0·18	0·33	0·17	0·27	0·32	0·16	0·17	0·52	0·24	0·26
	Y2	0·18	0·15	0·20	0·16	0·18	0·20	0·20	0·18	0·23	0·19	0·22	0·26	0·19	0·19	0·23	0·26	0·28	0·26

P.F.— pre-flowering. F —flowering. H—harvest. Y1—first year. Y2—second year.

TABLE IV—*Composition of Kolukattai grass and Rhodes grass grown under different manurial treatments*—1940-1941

		KOLUKATTAI GRASS									RHODES GRASS								
		Ammonium sulphate			Cattle manure			No manure			Ammonium sulphate			Cattle manure			No manure		
		P.F	F	H	P.F	F	H	P.F	F	H	P.F	F	H	P.F	F	H	P.F	F	H
Protein	N	11·69	14·29	12·35	12·78	10·69	8·78	10·61	10·46	9·50	10·34	10·64	7·77	6·65	6·43	4·89	7·61	7·07	6·45
	S	12·15	13·12	11·46	8·84	9·41	7·32	9·06	10·02	9·22	10·17	9·44	8·88	8·80	7·56	6·41	8·37	7·88	6·35
Ash	N	13·52	12·99	11·35	13·85	12·65	11·15	14·20	13·92	11·90	9·44	9·53	8·81	9·45	9·20	9·00	9·10	9·87	8·64
	S	13·07	13·52	11·17	12·13	14·45	12·20	14·23	15·72	14·84	9·50	8·78	9·41	9·60	9·29	9·13	10·18	9·38	8·56
Insolubles	N	6·98	4·92	4·06	6·80	5·15	4·58	7·04	6·84	5·85	3·74	3·99	3·47	4·51	4·27	4·65	4·16	5·60	4·26
	S	6·57	6·18	4·51	7·16	8·19	6·45	8·74	9·21	8·72	3·77	3·60	3·76	3·87	3·69	3·84	4·33	4·27	3·69
Solubles	N	6·54	8·07	7·29	7·05	7·50	6·57	7·16	7·68	6·05	5·70	5·54	5·34	4·94	4·93	4·35	4·94	4·17	4·38
	S	6·50	7·34	6·66	4·97	6·26	5·75	5·49	6·51	6·12	5·73	5·18	5·65	5·73	5·60	5·29	5·85	5·11	4·87
Lime (CaO)	N	0·47	0·51	0·56	0·44	0·41	0·36	0·40	0·44	0·36	0·63	0·69	0·65	0·63	0·64	0·51	0·62	0·60	0·52
	S	0·42	0·56	0·44	0·33	0·51	0·45	0·71	0·61	0·59	0·62	0·62	0·59	0·51	0·59	0·56	0·95	0·62	0·54
Phosphoric acid (P_2O_5)	N	0·35	0·41	0·32	0·50	0·48	0·41	0·33	0·35	0·34	0·26	0·26	0·18	0·39	0·36	0·43	0·26	0·25	0·22
	S	0·35	0·37	0·30	0·42	0·41	0·45	0·30	0·40	0·39	0·26	0·24	0·21	0·36	0·34	0·31	0·26	0·26	0·22
Total sulphur	N	0·23	0·18	0·23	0·19	0·15	0·17	0·15	0·13	0·16	0·25	0·25	0·20	0·20	0·21	0·20	0·25	0·24	0·24
	S	0·21	0·24	0·20	0·17	0·18	0·20	0·18	0·17	0·17	0·23	0·26	0·20	0·21	0·20	0·22	0·22	0·24	0·21

N—north series. P.F—before flowering stage. S—south series. F—flowering stage. H—harvest stage

TABLE V—*Composition of Kolukattai grass and Rhodes grass grown under different manurial treatments*—1941-1942

		NORTH SERIES						SOUTH SERIES					
		Control		Cattle manure		Ammonium sulphate		Control		Cattle manure		Ammonium sulphate	
		F	H	F	H	F	H	F	H	F	H	F	H
Kolukattai grass													
Protein	Y1	6·80	7·79	8·99	7·21	11·40	10·81	8·25	10·13	9·25	9·80	12·96	14·05
	Y2	7·64	4·22	6·70	4·67	11·77	7·68	6·79	5·02	6·18	4·06	11·57	8·12
Ash	Y1	26·89	23·89	25·25	14·30	20·65	13·61	30·63	19·74	22·61	16·51	23·34	13·95
	Y2	20·34	22·20	19·12	21·55	13·18	14·00	25·01	21·53	19·59	21·11	13·68	14·34
Insolubles	Y1	18·03	17·31	16·00	8·86	11·76	6·80	21·38	13·16	13·43	10·22	13·82	7·32
	Y2	13·04	16·46	12·32	15·42	5·07	7·72	17·79	14·96	13·50	14·50	11·57	6·57
Solubles	Y1	8·86	6·58	9·25	5·44	8·89	6·81	9·25	6·58	9·18	6·29	9·52	6·63
	Y2	7·30	5·74	6·80	6·13	8·11	6·28	7·22	6·57	6·09	6·61	2·11	7·77
Lime (CaO)	Y1	1·00	0·66	0·91	0·39	0·80	0·44	1·13	0·59	1·00	0·45	1·00	0·53
	Y2	0·88	0·88	0·96	0·86	0·47	0·52	1·08	0·74	0·91	0·81	0·90	0·52
Phosphoric acid (P_2O_5)	Y1	0·26	0·30	0·51	0·40	0·31	0·31	0·30	0·28	0·43	0·40	0·27	0·26
Rhodes grass													
	Y2	0·80	0·43	1·18	0·85	0·34	0.21	0·71	0·92	1·10	1·06	0·32	0·26
Protein	Y1	10·26	6·83	10·90	7·00	13·44	10·93	9·77	8·43	11·39	7·51	15·17	9·52
	Y2	7·03	6·00	5·67	3·49	11·86	8·06	8·25	5·70	6·28	4·34	10·76	8·38
Ash	Y1	13·72	9·46	11·77	12·07	10·31	9·79	11·26	11·02	13·13	10·63	13·56	10·91
	Y2	11·10	11·69	17·40	12·52	11·78	10·32	11·58	11·66	11·54	13·42	13·81	10·63

Insolubles	Y1	6·92	4·63	4·82	6·29	3·06	4·34	4·77	6·47	5·81	6·21	5·80	5·23
	Y2	5·86	6·52	10·52	8·05	5·87	4·90	5·92	6·94	6·55	8·56	4·32	4·51
Solubles	Y1	6·80	4·83	6·95	5·78	7·25	5·45	6·49	4·55	7·32	4·42	7·76	5·68
	Y2	5·24	5·17	6·88	4·47	5·91	6·42	5·66	4·72	4·99	4·86	11·49	6·12
Lime (CaO)	Y1	0·76	0·47	0·88	0·60	0·77	0·68	0·70	0·48	0·71	0·43	0·88	0·67
	Y2	0·57	0·56	0·85	0·64	0·75	0·67	0·54	0·54	0·86	0·64	0·63	0·63
Phosphoric acid (P_2O_5)	Y1	0·29	0·25	0·51	0·51	0·31	0·28	0·26	0·27	0·45	0·42	0·33	0·24
	Y2	0·46	0·24	1·00	0·62	0·32	0·15	0·38	0·31	0·58	0·52	0·28	0·45

F—flowering. H—harvest. Y1—first year. Y2—second year.

raised in the next year, and subjected to periodical analysis as before. The results are presented in Table III. In the third year, Kolukattai and Rhodes grasses were grown in replicated plots receiving the same types and doses of manuring and the samples were drawn at three definite stages of the crop growth, namely pre-flowering, post-flowering and at harvest. The data are presented in Table IV. In the next year the pastures failed to grow owing to the unfavourable season. From the latter half of 1939 the plots were manured with 'ammonium sulphate' and 'cattle manure' at the level of nitrogen at 200 pounds per acre, the control plots being left unmanured and two crops were raised in the two years. Every year samples were drawn at two stages of growth, namely, at flowering and at the dead ripe stage. The data are presented in Table V.

TABLE VI—*Statistical summary of chemical composition of Kolukattai and Rhodes grasses receiving different manures*

Minerals	Factors	Mean per cent mineral for each class of factor			Critical difference
Protein	Treatments	Am.S. 2·134	C 2.074	C.M. 1.508	0·118
	Stages	P.F. 2.320	F 1.784	H 1.612	0.118
	Years	Y2 2.143	Y1 1.668		0.096
	Grasses	G1 1.974	G2 1.836		0.096
Lime	Treatments	C 0.722	Am.S. 0.628	C.M. 0.565	0.070
	Stages	P.F. 0.708	F. 0.628	H. 0.598	0.070
	Years	Y1 0.664	Y2 0.624		0.057
	Grasses	G.1 0.664	G2 0.631		0.057
Phosphoric Acid	Treatments	Am.S. 0.501	C.M. 0.441	C 0.423	0.087
	Stages	P.F. 0.708	F. 0.628	H. 0.598	0.087
	Years	Y1 0.619	Y2 0.281		0.070
	Grasses	G1 0.472	G2 0.438		0.070

P.F.—pre-flowering. Y1—first year. G1—Kolukattai grass. Am. S.—Ammonium sulphate. F—flowering. Y2—second year. G2—Rhodes grass. H—harvest. C. M.—Cattle manure. C—Control.

RESULTS

The data of trials with two sources of nitrogen such as from cattle manure, and ammonium sulphate at 150 lb. nitrogen per acre on the quality of Kolukattai and Rhodes grasses when

statistically examined revealed the following (as may be seen from the summary presented in Table VI):

(*a*) Regarding protein, cattle manure is least favourable for improving it, while control and ammonium sulphate are of the same order but superior to cattle manure. Of the grasses, Kolukattai grass is definitely richer than the Rhodes grass in protein.

(*b*) As for lime content, the crop in the pre-flowering stage is significantly more nutritious than in the flowering or harvesting stage. There is no tendency for the grasses to increase in their lime content after the flowering stage.

(*c*) In regard to phosphorus though there is no great difference between the two varieties, the first year crops are significantly richer in it than those of the second year.

The statistical scrutiny of the analytical data are summarised in Table VII . The conclusions that may be derived from the data are :

(*a*) The grasses from the 'ammonium sulphate' series contain more protein at the two stages namely at flowering and at the time of harvest (dead ripe stage).

(*b*) The phosphoric acid content is best in the grasses from the 'cattle manure' plots.

(*c*) Grasses are of better nutritive value at the flowering stage than when they are older.

TABLE VII—*Statistical summary of Kolukattai and Rhodes grasses receiving different manures*

Minerals	Factors	Mean per cent mineral for each class of factor			Critical difference
Protein	Treatments	Am.S. 11.020	C. 7.740	C.M. 7.290	0.500
	Years	Y2 9.540	Y1 9.020	Y3 7.080	0.500
	Grasses	G1 9.12	G2 8.24		0.408
	Stages	F. 9.61	H. 7.75		0.408
Lime	Treatments	C. 0.663	C.M. 0.659	Am.S. 0.638	0.100
	Years	Y3 0.727	Y2 0.706	Y1 0.526	
	Grasses	G1. 0.671	G2. 0.635		0.040
	Stages	F. 0.738	H. 0.468		0.040
Phosphoric acid	Treatments	C.M. 0.571	C. 0.370	Am.S. 0.288	0.057
	Years	Y3 0.561	Y2 0.339	Y1 0.330	0.057
	Grasses	G1. 0.467	G2. 0.362		0.046
	Stages	F. 0.439	H. 0.381		0.046

F—flowering. Y1—first year. G1—Kolukattai. Am.S.—ammonium sulphate. H—harvest. Y2—second year. G2—Rhodes grass. C.M.—cattle manure. Y3—third year. C—control.

DISCUSSION

According to Blackman [1936] the effect of manure is dependent on the composition of the soil, soil temperature and soil moisture in addition to certain other factors. Orr [1929] has stressed that manuring of a soil with an element will have a favourable effect if it is deficient in that element. These facts have support in the evidence of the work by Bal and Athwale [1935]. Since the general findings are that basic slag or lime has no influence on the mineral composition of the grasses it is to be realised that in the calcareous soils of the State, the response does not seem to be evident. The favourable effect of manuring with ammonium sulphate on the protein content of Kolukattai and Rhodes grasses have ample corroboration in the findings of Chatterjee [1936-1937].

Regarding the stage of growth and nutritive quality too, the deterioration of the protein content with the progressive ripening and the reduction in the percentage of lime and phosphoric acid have been confirmed by Lander [1942]. Das Gupta [1940, 1942] studying the effect of age on the composition of berseem showed that the plants were richer in nutrients in the earlier stages of growth ; the yield of nutrients per acre being higher at the later stages. The experiments of Woodman *et al.* [1934] and Jones and Huston[1914] point to the same conclusion. It is well to realise in this connection, that the digestibility and availability of the nutrients in conjunction with their yield will finally determine the stage at which the maximum feeding value may be obtained and further work in this direction is warranted.

SUMMARY

Experiments were carried out in plots both at Hosur and Coimbatore to find out the effect of manurial treatment on the composition of pasture grass. Spear grass was grown at Hosur with farmyard manure, basic slag and lime in replicated plots. Composite samples from each treatment were analysed at three stages of growth, *viz.*, early, flowering and harvesting. Kolukattai and Rhodes grasses were raised in plots at Coimbatore. The manures tried were farmyard manure and ammonium sulphate. Samples were collected as in the case of Spear-grass and analysed. The results of the above trials covering a period of seven years are reported in this paper and may be summarized as :

(1) Ammonium sulphate has the effect of increasing the protein content of grasses.

(2) Cattle manure, on the other hand, is found to enhance the phosphoric acid content of pastures.

(3) A judicious combination of both ammonium sulphate and cattle manure will result in good quality pasture.

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XANTHOMONAS PUNICAE SP. NOV. **ON** *PUNICA GRANATUM* **L.**

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Hingorani and Mehta [1952] described a bacterial leaf-spot disease of pomegranate (*Punica granatum* L.) for the first time, but they did not identify the pathogen. The disease and its pathogen have now been studied in detail and the results are given in this paper.

The disease is characterised on leaves by small, irregular and water-soaked spots. The spots vary from 2 to 5 mm. in diameter with necrotic brown centres of pin-head size to begin with. The water-soaked spots, when viewed against light, look translucent. They turn light brown gradually and then dark brown and are surrounded by prominent water-soaked margins. The spots vary in size and number and, when numerous, may coalesce involving a large part of the leaf. Badly infected leaves become yellow and are easily shed. Bacterial ooze is sometimes found in the centre of the spots (Fig. 1). Spots do not appear on twigs, branches or fruits.

MATERIAL AND METHODS

Diseased leaves of pomegranate were collected from different trees in Delhi State as also from other parts of the country and six isolates were taken up for a detailed study. Since all these isolates were similar in all respects, the results with one isolate are given here.

The methods followed were those recommended by the Society of American Bacteriologists [1951]. The cultures were purified and grown on Nutrient-dextrose agar (*p*H 7.0) at 80·6°–86·0°F., unless otherwise mentioned.

EXPERIMENTAL METHODS

Pathogenicity : Cuttings of healthy pomegranate plants, when one to two months old, were used for inoculation purposes. The plants were kept in moist chamber for 24 hours before and after inoculation. Leaves for one set of plants were inoculated by injuring them with sterilized pods of *Xanthium strumarium* and the other without injury. Suitable controls were kept in each case. Infection appeared after nine days of inoculation on injured leaves and after 12 days of inoculation on uninjured leaves as numerous, minute, water-soaked spots. The symptoms closely resembled those found in nature. The control plants remained healthy.

Morphology : The pomegranate pathogen is a short rod with rounded ends; single or in pairs; sometimes in chains; no involution forms; 1-2·5 × 0·5 microns in size; motile with a single polar flagellum ; gram-negative; no endospores; capsule present; not acid-fast. It readily stains with common dyes like Gentian violet and Carbol fuchsin.

Cultural characters : Cultural characters of the organism were studied on various media prepared according to the standard methods. The growth observations are recorded in Table I.

Thus, nutrient-dextrose agar, yeast-glucose-chalk agar and potato cylinders are the best media for the cultivation of this organism because of the luxuriant growth obtained on them. The pathogen is facultative anaerobe.

Colonies on potato-dextrose agar are round, raised, wet, shining, with entire edges, colourless to pale yellow and measure 1-2 mm. in diameter after 5-6 days of growth.

The cardinal temperatures for growth of the pathogen are minimum 41°F., optimum 80·6°-86·0°F. and maximum 104°F. Its thermal-death-point is near 125°F. It can resist desiccation up to 14 days at 86°F.

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TABLE I—*Growth characters of the pathogen on different media*

Medium	Growth characters after 48 hours incubation
Nutrient agar	Growth, poor, filiform, slightly raised, glistening, butyrous, pale yellow, odour absent.
Nutrient broth	No surface growth, sediment flaky, slightly turbid and pale yellow, odour absent.
Nutrient-dextrose agar	Growth abundant, filiform, slightly raised, glistening, butyrous, pale yellow, odour absent.
2 per cent potato-dextrose agar	Growth fairly good, filiform, slightly raised, glistening, whitish yellow, odour absent.
Yeast-glucose-chalk agar	Growth abundant, filiform, slightly raised, glistening, butyrous, yellowish; medium slightly turned brown, odour absent.
Potato cylinders	Growth abundant, filiform, slightly raised, flowing like honey, pale yellow, discolouration occurs, odour absent.
Uschinsky's, Clara's and Czapek's solutions	No growth.

NOTE—With age, the bright yellow colour of the growth on yeast-glucose-chalk agar and potato cylinder gradually changes to quite dark brown.

Biochemical reactions : The pathogen utilizes xylose, glucose, mannose, galactose, sucrose, lactose and raffinose, but not maltose, glycerine and salicin when grown in Durham's fermentation tubes containing 1 per cent carbohydrates in a peptone-free synthetic liquid medium. Ammonia is produced in peptone water after 15 days. Nitrites, hydrogen sulphide and indole are not produced. Starch is hydrolysed. Methyl-red and Voges-Proskauer tests give negative results. Growth on gelatin slabs is good. Stratiform type of liquefaction commences after 48 hours and is completed within 21 days. The yellow colour of the growth on gelatin gradually changes from the usual bright yellow to dark brown as in the case of cooked potatoes and yeast-glucose-chalk agar. Litmus is not reduced, but coagulation with subsequent peptonization takes place.

The pathogen can tolerate only 3 per cent sodium chloride. It is, however, unable to grow in the synthetic asparagin medium of Starr and Weiss [1943] in the absence of glucose indicating thereby that asparagin as a sole source of carbon and nitrogen cannot be utilized.

Host range : The following hosts were inoculated, with and without injury, for determining host-range of the pathogen:

Abelmoschus esculentus Moench; *Alysicarpus rugosus* DC.; *Amaranthus viridis* L.; *Arachis hypogaea* L.; *Begonia* sp.; *Brassica campestris* var. *rapa* L.;*B. oleracea* var. *botrytis* L.; *B. oleracea* var. *capitata* L.; *Bridelia hemiltoniana* Wall.; *Butea frondosa* Konig.; *Cajanus cajan* (L.) Millsp.; *Capsicum frutescens* L.; *Cassia tora* L.; *Citrus sinensis* Osbeck; *Clerodendron* sp.; *Crotalaria juncea* L.; *Cucumis melo* L.; *C. sativus* L.; *Datura stramonium* L.; *Daucus carota* L.; *Desmodium diffusum* DC.; *D. diffusum-gangeticum* DC.; *Dolichos lablab* L.; *Euphorbia pulcherrima* Willd.; *Glycine max* Merr.; *Gossypium herbaceum* L.; *Ipoymoea muricata* Jacq.; *Lactuca sativa* L.; *Lawsonia alba Lamk.*; *Lycopersicon esculentum* Mill.; *Mangifera indica* L.; *Medicago sativa* L.; *Melilotus indica* All.; *Nicotiana tabacum* L.; *Papaver* sp.; *Phaseolus vulgaris* L.; *Pisum sativum* L.; *Prunus persica* Stokes; *Punica granatum* L.; *Pyrus communis* L.; *Raphanus sativus* L.; *Ricinus communis* L.; *Saccharum officinarum* L.; *Sesamum indicum* DC.; *Sesbania aegyptiaca* Poir.; *Solanum melongena* L.; *S. tuberosum* L.; *Sorghum vulgare* Pers.; *Stizolobium deeringianum* Bort.; *Tamarindus indica* L.; *Tephrosia purpurea* Pers.; *Trigonella foenum-graecum* L.; *Triticum aestivum* L.; *Vigna senensis* (L.) Endl.; *Vicia faba* L.; *Vitis vinifera* L.; *Woodfordia floribunda* Salisa.; *Xanthium strumarium* L.; *Zinnia elegans* Jacq.; *Zea mays* L.

The pathogen attacked only *Punica granatum* L.

Seasonal relationship : Effect of seasonal variation in temperature and humidity on disease development was determined by inoculating pomegranate plants at least once a month from March to November for three successive years. The tests had to be suspended during December to February as the plants shed their leaves. Successful infection was obtained only from middle of March to end of June when high temperature and low humidity are normally recorded in Delhi State. With the onset of monsoon, the disease could not be reproduced except once during the month of October when the inoculated plants were kept in glasshouse where low humidity and fairly high temperature (72°-105°F.) prevailed. Even then only a few leaf spots developed.

Survival of the pathogen : The vital role of fallen leaves in the survival of phytopathogenic bacteria causing leaf-spot diseases is well established [Burkholder, 1948; Crosse, 1957]. Experiments were, therefore, conducted to determine survival of the pomegranate bacterium in leaves under different conditions. Diseased leaves were collected in tissue bags on 10-12-'54 and kept outside for weathering up to 9-4-'55. Fortnightly isolations were made from these leaves and the pathogen was isolated every time. Simultaneously, fallen leaves from pomegranate trees were collected every 15 days and isolations made for the presence of the pathogen, which was easily obtained up to 120 days. Infected pomegranate leaves were also stored at room temperature (77°-86°F.). and the pathogen could be recovered from them up to five months. All the isolates thus obtained were found to be pathogenic to pomegranate plants when inoculations were made in April, 1955.

CONCLUSION

The data clearly show that the pomegranate bacterium belongs to the genus *Xanthomonas*. It is host-specific and differs slightly from all the other known species of *Xanthomonas* in that the yellow colour of the growth on gelatin, which it liquefies, and on yeast-glucose-chalk agar and cooked potato gradually changes from the usual bright yellow to quite dark brown. This discolouration, no doubt, is a specific character and it would be interesting to find out what the change is due to. In view of this, the authors feel justified in creating a new species. The pomegranate bacterium is, therefore, designated as *Xanthomonas punicae* sp.nov., technical description of which is given below :

Short rods with rounded ends; single or in pairs; sometimes in chains; measure $1 \cdot 0 - 2 \cdot 5 \times 0 \cdot 5$ microns in size, capsule present; motile with single polar flagellum, Gram-negative; no endospores and not acid-fast; stain readily with common dyes like Gentian violet and Carbol fuchsin. Colonies on potato-dextrose agar are round, raised, wet shining with edges entire, colourless to pale yellow and measure 1–2 mm. in diameter after 4–5 days of growth. Optimum temperature for growth is 80·6°–86°F., minimum 41°F. and maximum 104°F. Thermal-death-point is about 125°F. The bacterium resists dessiccation for 14 days at 86°F. Excellent growth takes place at *p*H 6·8 to 7·6, but none at *p*H 4·6 and 10·2. Good growth is obtained on Nutrient dextrose agar, Yeast–glucose–chalk agar and potato cylinders, but none in Uschinsky's, Clara's and Czapek's solutions. The organism liquefies gelatin and starch is hydrolysed. Growth on Yeast-glucose-chalk agar potato cylinders and gelatin gradually changes from bright yellow to dark brown. Nitrates are not reduced; indole and hydrogen sulphide not produced; ammonia produced; M. R. and V. P. tests negative. Litmus is not reduced but coagulation with subsequent peptonization takes place in litmus milk. Glucose, mannose, galactose lactose, xylose, sucrose and raffinose are utilized, but not glycerine, maltose and salicin. The pathogen is facultative anaerobe and host-specific to *Punica granatum* L.

The pathogen has been found to survive in fallen leaves during the off-season (December to middle of March), forming a source of inoculum when the conditions become favourable for the development of the disease. It has also been found that the disease can be artificially reproduced only from the middle of March up to the end of June when high temperature and low humidity prevail in Delhi State. Although no definite conclusions can be drawn from this, it seems probable that high temperature or low humidity or both favour development of the disease. This could not be confirmed due to lack of controlled conditions.

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SCREENING OF PYRETHRUM FLOWERS

RELATIONSHIP BETWEEN TOTAL PYRETHRINS, ETHER EXTRACTIVES AND ALKALI CONSUMED BY THE EXTRACTIVES

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Various methods such as Seils [Seils, 1947], mercury reduction [A.O.A.C. 1950] based upon the extraction, isolation and titration of chrysanthemum mono- and di-carboxylic acids; polarographic [Yamada *et al.*, 1952]; chromatographic [Ward, 1953]; colorimetric [Edwards, 1952; Cueto, 1953; Levy, 1954] and spectrographic [Beckley, 1949] have been recommended and some of them are in vogue for the assay of pyrethrum flowers. Almost all these methods are time consuming and require special equipment and highly trained personnel and as such are limited in their application for plant breeding work requiring mass screening of flowers where sometimes the samples to be screened might run into thousands. Notcult [1955] found a correlation between the total pyrethrin content of flowerhead and the number of oil glands on the achenes, and recommended counting of oil glands as a method of selecting plants of high pyrethrin content for breeding. Fresh flowers were used in the method. According to the author the method was likely to be somewhat inaccurate as the oil glands contain only about 12 per cent of the total pyrethrins. On this account he further recommended the dissection, necessary to display secretory ducts, this being a relatively difficult and time consuming job. The authors are, however, not aware of any biochemical relationship existing between the formation of essential oil and the pyrethroids in the flowers.

Pyrethrum flowers, besides pyrethrins and cinerins, are known to contain false pyrethrins *i.e.* biologically inactive polymerized products, chrysanthemum carboxylic acids and other esters of these acids apart from those formed with pyrethrelone and cinerelone. All these react with caustic alkali.

In the present investigations an attempt was made to make use of the abovementioned point and study the relationship which the extractives from the flowers and the consumption of alkali by the extractives might bear with the total pyrethrin content as determined for the different samples of pyrethrum flowers* by one of the recommended conventional methods (mercury reduction).

Pyrethrum flowers were extracted with petroleum ether 50-70°C fraction in the Soxhlet extraction apparatus. Petroleum ether was completely removed and the weight of extractives recorded for percentage extractives. As for reacting with alkali complete removal of petroleum ether was not necessary, it was just distilled off. Ten milligram of neutral alcohol was added to each ehrlenmeyer flask containing the extractives, refluxed for 5 minutes and titrated against standard alkali (N/10 caustic potash) to find alkali consumed for free acids. To each flask was then added 10 ml. of N/5 alcoholic potash, refluxing done for 1 to 1½ hours and titrated against N/10 hydrochloric acid to obtain alkali consumed for esters of chrysanthemum carboxylic acids. For estimating the total alkali consumed, most of the solvent was distilled off after extraction, 10 ml. of N/5 alcoholic potash was added to each flask containing the extractives, refluxed for 1 to 1½ hours and titrated against N/10 hydrochloric acid. The results obtained are given in Table I.

Table I shows that fairly good linear relationship exists between the total pyrethrins as determined by the mercury reduction method and percentage extractives, alkali consumed by free acids, alkali consumed for the decomposition of esters of Chrysanthemum carboxylic acids and the total alkali consumed.

*Some of the samples were obtained through the kind courtesy of Shri G.D. Gokhale of the Bombay Chemicals Bombay.

TABLE I—*Relationship between total pyrethrine content, per cent extractives and alkali consumed by the extractives*

	I	II	III	IV	V	VI					
Sample No.	Per cent total pyrethrins as determined by the mercury reduction method	Per cent Extractives from Soxhlet extraction	Factor mean content mean per cent Exts.	Computed content II × III per cent	Variation	Extractives from 10 gm. of pyrethrum flowers Soxhlet Extr.					
						Milligrams of KOH required to neutralize free acids A	Milligrams of KOH required for decomposition of esters B	Milligrams of KOH required for decomposition of extractive C	Factor mean content mean(C) D	Computed content per cent C×D	Variation per cent
1	0.75	3.31		0.82	+0.07	11.2	47.04	59.36		0.79	+0.04
2	0.79	3.22		0.80	+0.01	10.64	50.40	61.60		0.82	+0.03
			1.015						1.015		
			4.07						75.94		
3	1.04	4.22		1.05	+0.01	12.88	59.92	73.36		0 98	—0.06
4	1.28	4.80		1.20	—0.08	16.80	77.28	94.64		1.26	—0.02
			=0.249						=0.0133		
5	1.22	4.65		1.16	—0.06	16.80	74.48	92.40		1.23	+0.01
6*	1.01	4.24		1.06	+0.05	14.56	59.36	74.48		0.99	—0.02
Mean	1·015%	4·07		Mean ±0·05% variation			Mean	75·94		Mean variation =0·03%	

*Composite (1:5:1:1)

Variations in the relationship are possible in so far as the alkali consumed for free acids and for the decomposition of esters of chrysanthemum acids are concerned for these might depend upon the stage at which the flowers have been collected; conditions under which the flowers were dried and stored as well as on the period of storage. However, the total alkali consumed is likely to conform to the trends indicated in these investigations and this may be a good index for plant breeder to select his material.

The findings, of course, are based upon observations recorded on six samples (including one composite sample) that could become available. It may be possible to evolve a statistical relationship by analysing larger number of samples. The procedure also has potentialities for pyrethrum extracts and insecticides. Investigations in this direction are to be pursued.

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AN ANALYSIS OF FACTORS UNDERLYING THE SPECIALISATION OF PARASITISM WITH SPECIAL REFERENCE TO *FUSARIUM SOLANI* (MART.) APP. *ET* WR. VAR. MINUS WR. AND *FUSARIUM FRUCTIGENUM* FR.

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Fungi (like rusts and mildews) are highly specialised as far as their host range is concerned, and with the present state of our knowledge it appears difficult to analyse the factors responsible for such high degree of specialisation in their parasitism. With a view to obtain some information on such highly specialised organisms, to begin with, less specialised fungi namely *Fusarium solani* (Mart.) App. *et* Wr. var. *minus* Wr. and *Fusarium fructigenum* Fr. were taken up for study. *F. fructigenum* is normally parasitic on apple and fails to attack potato, whereas *F. solani* is parasitic on potato and less actively parasitic on apple. Experiments reported herein were, therefore, conducted with a view to find out the causes for the failure of *F. fructigenum* to attack potato and for the lower activity of *F. solani* on apple.

The cultures of *Fusarium solani* App. *et* Wr. var. *minus* Wr. and *Fusarium fructigenum* Fr. used in the investigation were obtained from the Indian Type Culture Collection and maintained on oat meal agar.

Potato variety *Phulwa*, was used for inoculation studies. In the case of apples, no particular variety could be used as one single variety was not available throughout. The apples used were a selection from the market having uniform, colour size and ripeness.

Inoculations were done using spores of the two fungi according to the method described by Granger and Horne [1924] and modified by Vasudeva [1930]. Quantitative estimation of the rot produced was made by actually weighing the affected tissue at the end of seven days incubation at 24-26°C. after making sure that the rot had been caused only by the fungus with which inoculation had been made.

Brown's synthetic medium* was used in all the nutritional experiments and the fungal enzyme extracts were prepared according to the method described by Brown (1915). The extracts were tested for enzyme activity using potato and apple discs 50 μ in thickness and noting the time taken for the loss of coherence of the cell walls.

EXPERIMENTAL METHOD

Parasitic activity of F. solani *and* F. fructigenum *on potato and apples :* To ascertain the inherent ability of the two fungi to parasitise directly, individual potatoes and apples were inoculated at 3 points with uniform spore suspension as follows : (i) with a drop of spore suspension of *F. solani*, (ii) with spores of *F. fructigenum*, and (iii) with sterilized water to serve as check. The rot caused in each case was weighed seven days after inoculation, *i.e.* before any overlapping of the rot took place. It was observed that in all cases on potato, *F. solani* attacked vigorously, whereas *F. fructigenum* failed to infect any of the inoculated tubers. The controls remained healthy. On the other hand apples were more vigorously attacked by *F. fructigenum*. *F. solani* even though parasitised the apple tissue, the amount of rot caused was comparatively much less. The data of such an experiment are set out in Table I. Studies on germination indicated the capacity of the spores of the above two fungi to germinate freely in the extracts of both potato and apple indicating thereby that the failure of attack was not due to any deleterious effect of the plant juice.

*Composition : Glucose, 2·0 gm. ; Asparagin, 2·0 gm. ; K_3PO_4, 1·2 gm. ; $MgSO_4$, 0·75 gm. ; and distilled water to make up to 1000 cc.

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TABLE I—*Parasitic activity of* Fusarium solani *and* F. fructigenum

Number	Apple			Potato		
	Rot caused by			Rot caused by		
	F. solani (gm.)	*F. fructigenum* (gm.)	Control	*F. solani* (gm.)	*F. fructigenum* (gm.)	Control
1	1·58	3·15	0·0	2·68	0·0	0·0
2	1·45	3·45	0·0	1·79	0·0	0·0
3	1·46	3·13	0·0	3·64	0·0	0·0
4	1·75	3·42	0·0	2·85	0·0	0·0
5	1·58	3·65	0·0	1·94	0·0	0·0
6	1·45	3·50	0·0	1·45	0·0	0·0
7	1·76	3·05	0·0	3·54	0·0	0·0
8	1·45	3·68	0·0	2·05	0·0	0·0
9	1·68	3·15	0·0	..	..	..
10	1·51	2·91	0·0	..	..	..

In view of the observations recorded in Table I and germination studies indicating that failure to attack the tissue is not due to any deleterious effect of the plant juice, it was considered necessary to investigate the role of the enzymes secreted by the two organisms to see if the inability of *F. fructigenum* to attack the potato tissue and weaker parasitic activity of *F. solani* on apple tissue could be ascribed to the activity of the enzymes in these cases.

The method of preparation of the enzyme was essentially the same as described earlier by Brown [1915] and later by Vasudeva [1930]. Clarified juice of the host was used as a nutrient medium for the germination and growth of the spores depending on the fungus in question. Two kinds of enzyme preparations, one obtained from the medium in which the spores had been grown and the other from the germ tubes themselves, were used for these experiments. They are referred to hereafter as 'exo' and 'endo' enzymes respectively.

Activity of different samples of enzyme preparations is compared by noting the time taken by each sample to destroy the coherence of the susceptible tissue. The coherence is said to be lost when the discs as tested between the fingers offer no perceptible resistance to a pulling stress. In the present case, discs of 50 μ thickness and 18·8 mm. diameter had been used as test pieces and the point at which the discs had lost coherence was taken as an end point. The effect of 'exo' and 'endo' enzymes of *F. solani* and *F. fructigenum* as secreted in potato and apple juice respectively was tested on potato and apple discs. The results of such experiments are set out in Tables II and III.

It would be observed that the 'endo' enzymes secreted by both the fungi are relatively more active than the 'exo' enzymes. Although the enzyme preparations from both *F. solani* and *F. fructigenum* show considerable activity on apple tissue, the external and internal enzymes of *F. solani* bring about loss of coherence in potato tissue. The enzyme preparations of

TABLE II—*Effect of 'exo' and 'endo' enzymes of* Fusarium solani *on potato and apple discs*

Dilution of enzyme	Time (mts.) required for disintegration of discs			
	Potato		Apple	
	'Exo' enzyme	'Endo' enzyme	'Exo' enzyme	'Endo' enzyme
Full strengh	75	30	45	15
90 per cent	105	30	45	15
80 „ „	105	30	45	15
70 „ „	105	45	45	15
60 „ „	120	45	60	15
50 „ „	120	45	60	15
40 „ „	120	45	60	15
30 „ „	135	45	60	15
20 „ „	135	60	60	15
10 „ „	150	75	75	15
5 „ „	150	90	90	30
1 „ „	..	105	90	30
C_1 „ „	..	..	..	..
C_2 „ „	..	..	..	..

C_1 Control in potato juice.
C_2 Control in sterile water.
.. Sound, coherence not lost.

TABLE III— *Effect of 'exo' and 'endo' enzymes of* F. fructigenum *on apple and potato discs*

Dilution of enzyme	Time (mt.) required for disintegration of discs			
	Apple		Potato	
	'Exo' enzyme	'Endo' enzyme	'Exo' enzyme	'Endo' enzyme
Full strength	75	30	195	105
90 per cent	75	30	195	135
80 „ „	75	30	..	135
70 „ „	90	30	..	180

TABLE III—*Contd.*

Dilution of enzyme	Time (mt.) required for disintegration of discs			
	Potato		Apple	
	'Exo' 'enzyme	'Endo' enzyme	'Exo' enzyme	'Endo' enzyme
60 per cent	90	30	..	180
50 „ „	105	45	..	..
40 „ „	105	45	..	..
30 „ „	105	45	..	..
20 „ „	120	45	..	..
10 „ „	120	45	..	..
5 „ „	120	90	..	..
1 „ „	..	..	..	..
C_1 „ „	..	..	..	..
C_2 „ „	..	..	..	..

C_1 Control in apple juice.
C_2 Control in sterile water.
.. Sound, coherence not lost.

F. fructigenum though indicate certain amount of activity at dilutions of 60 to 100 per cent they fail to disintegrate the potato tissue at lower concentrations.

To further test the role of enzymes, inoculations were conducted in the usual manner at four points on each tuber or fruit, as follows :

No. 1 . . . . . Inoculations with test organism *F. solani.*
No. 2 . . . . . Inoculation with test organism 1+*enzyme.*
No. 3 . . . . . Inoculation with test organism *F. fructigenum.*
No. 4 . . . . . Inoculation with test organism 3+*enzyme.*

In the case of treatment No. 2 and 4 equal doses of the sterilized enzyme solutions were supplied just before inoculation with the test organism. The results obtained are set out in Tables IV and V.

It is observed that (i) parasitic activity of *F. solani* is enhanced when it is reinforced with its active 'exo' or 'endo' enzyme and the differences are significant, the values for 't' being 5·892, 10·889, 3·843 and 9·616 for 'exo' and 'endo' enzymes respectively, (ii) *F. fructigenum* which is normally not parasitic on potato when reinforced with 'exo' or 'endo' enzymes of *F. solani* is able to parasitise the tissue, 't', in the two cases being 2·392, 2·50, 3·16 and 2·29 respectively, and (iii) *F. fructigenum* although able to attack apple vigorously could not parasitise potatoes even when reinforced with its active 'exo' enzyme.

Both *F. solani* and *F. fructigenum* were capable of attacking their respective hosts and more vigorously when reinforced with their respective enzymes. When *F. solani* was reinforced with the enzyme of *F. fructigenum* it could more actively parasitise the apple tissue, and

TABLE V—*Effect of 'exo' and 'endo' enzymes of* F. solani *on infection on potato and apple*

	'Exo' enzyme								'Endo' enzyme							
	Potato				Apple				Potato				Apple			
No.	Rot by *F. solani* (gm.)	Rot by *F. solani* + enzyme (gm.)	Rot by *F. fructigenum* (gm.)	Rot by *F. fructigenum* + enzyme(gm.)	Rot by *F. solani.* (gm.)	Rot by *F. solani* +enzyme (gm.)	Rot by *F. fructigenum* (gm.)	Rot by *F. fructigenum* +enzyme(gm.)	Rot by *F. solani* (gm.)	Rot by *F. solani* +enzyme (gm.)	Rot by *F. fructigenum* (gm.)	Rot by *F. fructigenum*+ enzyme (gm.)	Rot by *F. solani* (gm.)	Rot by *F. solani* +enzyme (gm.)	Rot by *F. fructigenum* (gm.)	Rot by *F. fructigenum* +enzyme (gm.)
1	1·98	3·23	0·0	0·98	1·51	1·98	2·98	3·96	1·62	3·24	0·0	1·12	1·02	1·98	2·44	3·02
2	1·76	2·98	0·0	0·88	1·42	2·02	2·58	3·41	1·58	2·94	0·0	1·02	1·51	1·88	2·56	3·43
3	1·87	2·88	0·0	1·02	1·02	2·01	2·12	3·81	1·78	3·31	0·0	1·04	1·42	1·88	2·31	3·02
4	2·02	3·04	0·0	1·04	1·54	2·61	3·02	3·88	1·58	2·42	0·0	0·98	1·14	1·78	2·58	3·41
5	2·21	3·22	0·0	1·02	1·58	1·98	2·61	3·54	1·61	3·02	0·0	1·02	1·61	2·12	2·08	4·21
6	Contaminated		Contaminated		1·56	1·99	2·51	3·78	1·72	3·08	0·0	1·12	1·14	1·92	2·62	3·56
7	1·83	2·98	0·0	0·89	Rots overlapped		Rots overlapped		1·52	3·62	0·0	0·94	1·51	1·94	2·52	3·24
8	1·90	2·56	0·0	0·99	1·72	2·34	3·42	5·12	1·72	3·12	0·0	0·89	Rots overlapped			
9	2·41	3·56	0·0	1·20	1·21	1·42	2·34	2·91	1·62	3·24	0·0	1·24	1·14	1·72	1·98	2·78
10	1·98	3·23	0·0	1·10	1·56	1·98	2·41	3·02	1·12	1·98	0·0	0·92	1·16	1·92	2·72	3·57
11	2·04	2·98	0·0	1·04	Contaminated				Contaminated				Contaminated			

TABLE VI—*Effect of 'exo' enzyme of* F. fructigenum *on infection on potato and apple*

Potato				Apple			
Rot by *F. solani* (gm.)	Rot by *F. solani* + enzyme (gm.)	Rot by *F. fructigenum* (gm.)	Rot by *F. fructigenum*+ enzyme (gm.)	Rot by *F. solani* (gm.)	Rot by *F. solani* + enzyme (gm.)	Rot by *F. fructigenum* (gm.)	Rot by *F. fructigenum* + enzyme (gm.)
1·68	1·70	0·0	0·0	0·67	0·75	0·80	1·04
1·42	1·51	0·0	0·0	0·77	1·12	0·89	1·18
1·51	1·44	0·0	0·0	0·88	1·29	0·84	1·07
1·24	1·31	0·0	0·0	0·82	1·17	1·12	1·82
1·42	1·34	0·0	0·0	0·79	1·02	1·03	1·40
Contaminated		Contaminated		0·74	1·34	1·02	1·55
1·51	1·44	0·0	0·0	0·79	1·15	1·00	1·70
1·46	1·48	0·0	0·0	0·79	1·21	1·02	1·77
1·38	1·29	0·0	0·0	1·02	1·40	1·42	1·82
1·29	1·34	0·0	0·0	0·85	0·78	1·04	1·15
1·37	1·42	0·0	0·0	0·96	1·53	1·43	1·96
1·47	1·51	0·0	0·0	0·68	1·05	1·33	1·88

F. fructigenum when reinforced with the 'exo' and 'endo'enzyme of *F. solani* successfully parasitised the potato tissue which it normally failed to do so. The amount of maceration, however, if any, by the addition of the enzyme of *F. solani* alone was not determined so that the attack shown to be due to *F. fructigenum* would also include the effect of enzyme of *F. solani*.

SUMMARY

The 'endo' and 'exo' enzymes secreted by *Fusarium solani* and *Fusarium fructigenum* have been found to be responsible for their parasitic activity on potato and apple respectively. *F. solani* although not actively parasitic on apples can attack more vigorously when reinforced with its own enzyme or that of *F. fructigenum*.

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'LINE PATTERN' DISEASE OF PLUM (*PRUNUS DOMESTICA* L.)

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(With 1 Text Figure)

A disease of plums designated as 'line pattern' has been reported from different states in the U. S. A. Similar infections in plums are known to occur in certain European countries [Anon., 1952 ; Cation *et al.*, 1951 ; Posnette and Harris, 1952]. It has also been recorded from Canada [Conners, 1942], and recently from New Zealand [Chamberlain *et al.*, 1951]. The disease, however, appears to have been recorded for the first time by Vallueau [1932]. It has been described by various workers under different names, the most common names besides 'line pattern' being 'Shiro line-pattern', 'peach line-pattern virosis', 'banded chlorosis', and 'vein-banding', etc. [Cation *et al.* 1951 ; Posnette and Harris, 1952]. Though most of the workers have assigned the disease to only one virus, Posnette and Harris [1952] considered it to be caused by several viruses.

During the course of survey for virus diseases of stone-fruits in the Simla Hills, plums (*Prunus domestica* L.) have been found to be affected by a disease similar to the 'line pattern'. The diseased trees have been observed in two widely separated suburbs of Simla, viz., Darni and Chhota Simla.

There is another disease caused by the peach 'golden-net' virus which, besides peach and apricot, also affects Satsuma plum (*Prunus salicina*) [Bodine and Durrell, 1951]. It, however, appears to be different from the disease under report because, on plum it produces only an inconspicuous marginal mottle on leaves.

Symptoms of the disease in plums: The disease symptoms are generally manifested after about a month of new growth in the spring. The disease starts with conspicuous vein-clearing in part or whole of the lamina. Subsequently, the veins including finer veinlets become bright yellow. The leaves showing the yellow veinal network persist till fall. In some of the leaves, the yellow chlorosis extends to the interveinal areas, and sometimes the lamina becomes partly or wholly chlorotic ; rarely oak-leaf patterns are also formed. There is no malformation or apparent reduction in leaf-size. The symptoms are manifested mostly on leaves which are comparatively older. Occassionally, a few shoots appear amidst diseased branches which do not show any apparent symptoms for a long time. Fig. 1 shows the range of symptoms on plum leaves. No conspicuous symptoms have been observed in fruits except a very faint mottling of the skin while still green and diffuse chlorotic spots on ripening in case of fruits of severely diseased trees.

In some plum trees, slightly different type of symptoms have been observed. In early stages, most of the finer veinlets remain normal green while the main veins, in part or whole of the lamina, appear as conspicuous bright yellow streaks against the normal green of the leaf. In advanced stages, the affected portions of the leaves become completely chlorotic and parchment-like. The first type of symptoms as shown in Fig. 1 are, however, more common in the affected plum trees.

Transmission: The disease was successfully transmitted by grafting to seedling plum (*P. domestica*). The diseased scions taken from shoots exhibiting typical symptoms as shown in Fig. 1 were grafted in dormant stage by 'cleft' method on healthy seedling plum stocks during February, 1955. The first new growth in the scion did not show any symptoms but with the advance of season the entire leaves developed severe symptoms of the disease. No symptoms were observed in the stock during 1955 growing season. However, typical symptoms appeared

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Fig. 1. Showing first range symptoms of 'Line Pattern' disease on plum leaves

in leaves on the shoots coming from the stock during March-April, 1956, i.e., after about a month of breaking of dormancy. In all, five grafts were successfully established. In two grafts, however, no growth took place in the stocks after the break of dormancy and only the scion resumed growth which continued, showing persistently the disease symptoms. Out of the remaining three grafts, transmission of the disease to the stocks was obtained in two grafts.

Further investigations on the disease are in progress and different varieties of plums and other *Prunus* species are being tested.

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STUDIES ON BORON DEFICIENCY AND TOXICITY SYMPTOMS IN SOME COMMON CROPS OF GUJARAT

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The study of visual symptoms is a direct and rapid method of diagnosing nutritional disorders like deficiency and toxicity diseases. The type of symptoms induced by a nutrient deficiency may vary from species to species and sometimes from variety to variety [Hobbs and Bertramson, 1950 ; and Wallace, 1951]. Several cultural techniques. such as sand-culture, gravel-culture and water-culture can be employed to study the symptoms arising out of nutritional disorders. In the present investigation a detailed study is made on the deficiency and toxicity symptoms in five common crops of Gujarat when boron is absent or present in excessively large quantities, using sand-culture technique. The crops selected are as follows :

1. Indian bean (Surati variety)	*Dolichos lablab* L.
2. Tobacco (K-49)	*Nicotiana tabacum* L.
3. Onion (local)	*Allium cepa* L.
4. *Guvar* (Makhania)	*Cyamopsis psoralioides*
5. *Bajri* (207)	*Pennisetum typhoideum*

Preparation of media for growth

For sand-culture experiment, glazed china-clay pots, 7 inches in height and 5 inches in diameter, with a $\frac{1}{2}$-inch drainage hole at the base of the wall, were chosen. The sand was passed through 2 mm. sieve and all the bigger particles like stones, bricks, etc. were picked up. The sand was then washed with tap water in $\frac{1}{2}$ mm. sieve to remove dust and soil, if any, and dried. The dried sand was then agitated for three to four hours with hydrochloric acid (2 litres of con. HCl+4 litres of water for every 100 lb. of sand) and was kept overnight. After this the sand was washed in running tap water, acid treatment was repeated and the sand was washed till the acid was removed completely. Finally the sand was washed three to four times with distilled water and filled in pots.

Nutrient solution : The composition of the nutrient solution is given below :

Major elements

KNO_3	1·01 gm. per litre	K—390 p.p.m.
$Ca(NO_3)_2$	0·16 gm. per litre	Ca—80 p.p.m.
$Ca(H_2PO_4)_2$	0·23 gm. per litre	PO_4—190 p.p.m.
$MgSO_4$	0·12 gm. per litre	Mg—24 p.p.m.
		NO_3—744 p.p.m.
		SO_4—96 p.p.m.

Minor elements

			Stock solution
Iron	2·00 p.p.m.	$FeSO_4, 7H_2O$	10 gm. per litre
Manganese	1·00 p.p.m.	$MnCl_2, 4H_2O$	3·62 gm. per litre

			Stock solution
Zinc	0·05 p.p.m.	$ZnSO_4, 7H_2O$	0·22 gm. per litre
Copper	0·05 p.p.m.	$CuSO_4, 5H_2O$	0·20 ,, ,, ,,
Molybdenum	0·01 p.p.m.	H_2MoO_4, H_2O	0·02 ,, ,, ,,

(1 ml. per litre to be added from stock solution).

All the reagents used were of B.D.H. 'analar' grade.

Boron concentrations ranged from 0.001 to 50.00 p.p.m. with a control as per Table I.

Cultural technique : Seedlings of tobacco and onion were transplanted after washing the roots first with tap water and then with distilled water. The roots of seedlings were kept immersed in boron-free nutrient solution for an hour and in the evening time these seedlings were transplanted in sand. In the case of Indian bean, *bajri* and *guvar*, seeds were sown. Healthy seeds were selected, washed with water and kept in boron-free nutrient solution for three hours. Six seeds were sown in each pot. After sprouting, one plant was allowed to grow in each pot. The plants were supplied every day with nutrient solution three times and with distilled water once. The pots were flushed with distilled water once a week to remove accumulated salts. In the beginning the plants were supplied with boron-free nutrient solution for one week and then they were supplied with solutions containing boron in different amounts. During the growth period the deficiency and toxicity symptoms were recorded. In general, toxicity symptoms appeared earlier than deficiency symptoms. (Table I).

Visual symptoms

Indian bean (Dolichos lablab *L.*) : Surati variety of Indian bean was selected for the study. In the case of deficiency, the lower leaves showed interveinal chlorosis and new-coming leaves were dark green in colour and brittle. This dark colour and brittleness decreased as the concentration of boron increased. After 50 days the leaves showed water-soaked areas and started drying from the base to the tip. Flowering was delayed in the case of deficient plants. Flowers were also less in number as compared to normal ones. Seedless pods developed. After 14 days of boron application, the toxicity symptoms appeared at 50 p.p.m. There was slight chlorosis on the leaf which spread all over the leaf within two days and brown spots appeared which were followed by marginal scorching from the periphery of the leaves. This scorching increased from the tip to the base and from margins to the mid-rib. Finally, the whole plant gave the appearance of burning.

Tobacco (Nicotiana tabacum) : A commercial variety of *bidi* tobacco (K-49) was selected for the present work. The first deficiency symptoms were observed in the new-coming leaves, which were pale green in colour. This was followed by the curling of the leaves towards the base. The lower leaves became dark green and brittle and uneven. The new-coming leaves were small in size. The growth of the plant was also stunted. After 60 days the growing point turned brown and died which is commonly known as top sickness of tobacco. The auxiliary buds developed but they also showed similar symptoms.

In the case of toxic concentrations, marked toxicity symptoms were observed. Brown circular spots developed on the periphery of the leaf and finally the whole leaf showed the burning effect and the plant died.

Onion (Allium cepa *L.*) : In the case of onions the toxicity symptoms appeared earlier than deficiency symptoms. In toxicity symptoms the tips of the leaves started drying up giving the appearance of burning. This burning increased from the tip to the base of the leaf. Older leaves suffered much. The plant receiving 50 p.p.m. of boron died earlier. The leaves were quite small and the bulb did not develop properly. In boron-deficient plants, stunted growth was observed. The tip of the leaves showed slight chlorosis. After some days the ladder-like rings appeared on the new-coming leaves and also there were transverse cracks in the middle of the new-coming leaves. The colour of the leaves in the case of deficient plants was light green.

Guvar (Cyamposis psoralicides) : The variety known as Makhania was selected for the present study. Toxicity symptoms appeared first. In the case of severe toxicity, the burning of the base of the leaves was marked. This burning increased from the base to the tip of the leaf. This was followed by angular scorching. The leaves curled upwards and finally the whole plant was affected. In the case of boron deficiency, slight chlorosis at the basal leaves was observed. The leaves were brittle and pale green in colour. In the case where the plant did not receive any amount of boron, necrotic areas also appeared on the basal leaves. Growth was also stunted.

Bajri (Pennisetum typhoideum) : *Bajri* 207 variety was chosen for the present investigation. In the case of toxicity, tips of the leaves started burning. This burning effect increased from the margin to the mid-rib and from the tip to the base. On the basal leaves small necrotic areas appeared at the margins and slowly proceeded towards the top of the plant. The whole plant was affected and died. In boron-deficient plants, the growth was stunted and internodes were short. The colour of the leaves was faint green. Slight yellowing at the tip of the leaves was also noted. However, the plant did not show any characteristic deficiency symptoms.

DISCUSSION

The growth of onion, bean and *bajri* was normal when the nutrient solution contained 0·01 p.p.m. of boron. In the case of *guvar* it was 0·1 p.p.m. and in the case of tobacco 0·5 p.p.m. which shows that the boron requirement of bean, onion and *bajri* is low, that of *guvar* intermediate and that of tobacco high.

Boron deficiency and toxicity symptoms observed for the five crops were somewhat similar except in certain characteristic symptoms of individual crops. In the case of *bajri* and *guvar*, deficiency symptoms appeared after 35 days and at a boron level higher than 0·5 p.p.m., the tip of the leaves showed burning effect. In the case of tobacco and Indian bean, deficiency symptoms appeared after 40 days. In tobacco, the symptoms were characterised by curling of the leaves towards the base. The growing point turned brown. But in the case of the beans interveinal chlorosis was quite marked. The leaves showed water-soaked areas and started drying from the base to the tip. The one outstanding feature was the formation of seedless pods. Toxicity symptoms appeared above 5 p.p.m. boron level in both these crops and brown circular spots appeared on the periphery of the leaves. Forty-five days after transplanting, deficiency symptoms appeared in onions. Chlorosis increased slowly from the tip of the leaves to the base. After some days, ladder-like rings appeared on the new-coming leaves. Injurious effects were noted at 0·5 p.p.m. but were more marked at 5 p.p.m. level. The tip of the leaves started drying giving an appearance of burning. The bulbs were not well developed.

Ca : B ratio

Several investigators have laid emphasis on calcium-boron relationship in the absorption and metabolism of boron by plants. Jones and Scarseth [1944] have emphasised the importance of Ca : B ratio in the plant. They found that plants made normal growth when certain balance in the Ca : B intake existed. In a detailed study of Ca : B relationship in tomato plant nutrition. Reeve and Shive [1944]concluded that the response of tomato plant intimately related was to the Ca : B ratio. Grake, Sieling and Scarseth [1941] suggested the possibility of using the ratio of Ca : B in plants as a guide in determining the need of boron fertilisation of Turkish tobacco. A number of other investigators [Burger and Truog, 1945, Brennan and Shive, 1948 ; Brenchley and Warington, 1927 ; Jones and Scarseth, 1944 ; Loranz, 1941 ; Marsh and Shive, 1941 ; Reeve and Shive, 1944 ; Shive, 1945] have also reported an apparent relationship between the calcium in the soil and availability of boron to plants. In view of the importance of this relationship, the boron and calcium contents were determined in plants grown in sand-culture.

Hatcher and Wilcox [1950] method was used in the present investigation for the estimation of boron. Calcium was determined in the usual way.

TABLE I—*Deficiency and toxicity symptoms in plants at different levels of applied boron*

Name of the Crop	Time of the 1st appearance of deficiency symptoms	Control with no boron	Concentration of boron in nutrient solution (p.p.m.)					
			0.001	0·01	0·10	0·50	5·00	50·0
Indian bean (*Dolichos lablab* L.) Surati	40 days after germination	Lower leaves showed interveinal chlorosis ; the new-coming leaves were dark green in colour and brittle ; after 50 days the leaves showed water-soaked areas and started drying from the base to the tip ; flowering was delayed ; pods formed were without seeds	..	Normal	..	Growth was depressed compared to normal ones	Slight chlorosis followed by dark brown spots on the leaf, and marginal scorching on the periphery of the leaves, which increased from the tip to the base and from margin to the mid-rib ; small leaves with pale green colour	
Tobacco (*Nicotiana tabacum*, L.) (K-49)	40 days after transplanting	Leaves dark green brittle and uneven ; curling of the bud leaves towards the base ; stunted growth ; the growing point turns brown (top sickness of tobacco) ; auxiliary buds as they developed produced the same type of symptoms	..	The colour of the bud was pale green; stunted growth	..	Normal	Toxicity symptoms appeared earlier than def. symptoms ; brown circular spots appeared on the periphery of the leaves	The symptoms appeared after the 3rd day of applying 60 p.p.m. of boron. Brown circular spots appeared on the periphery of the leaves; finally the plant died
Onion (*Allium cepa* L.) Local	45 days after transplanting	Tips of the leaves showed chlorosis which increased slowly from the tip to the base of the leaves; after some days ladder-like rings appeared on the new-coming leaves; the growth was stunted; small bulb developed	..	..	Normal	Very slight burning at the tips of the leaves was observed ; normal in other respects	The tips of the leaves started drying up giving an appearance of burning ; this burning increased from the tip to the base of the leaves ; older leaves suffered much; the leaves were small and thin; bulb was not developed	

Name of the Crop	Time of the 1st appearance of deficiency symptoms	Control with no boron	Concentration of boron in nutrient solution (p.p.m.)				
			0.001	0.1	0.10	0.50	50.0
Guvar (*Cyamopsis psoralioides*) (Makhania)	35 days after germination	Vegetative growth was depressed ; stem was very thin ; roots did not develop properly ; chlorosis at the basal leaves ; new leaves small in size	Vegetative growth was depressed ; stem was very thin ; roots did not develop properly; chlorosis at the basal leaves; new leaves small in size	The leaves were pale green in colour	Normal	Burning at the base of the leaf was observed	The burning of the base of the leaf was marked ; this burning increased from the base to the tip of the leaves ; this was followed by angular scorching ; the leaves curled upwards

Name of the Crop	Time of the 1st appearance of deficiency symptoms	Control with no boron	Concentration of boron in nutrient solution					
			0.001	0.01	0.1	0.30	0.50	50.0
Bajri (*Pennisetum typhoideum*) (207)	35 days after germination	Stunted growth and short internodes ; the colour of the leaves was pale green ; yellowing at the top of leaves ; ear-head appeared but later than in the normal plant	Stunted growth and short internodes ; the colour of the leaves was pale green ; yellowing at the top of leaves; ear-head appeared but latter than in the normal plant	Normal	Normal	Normal	Tips showed burning effect which was followed later by development of necrotic spots along the margins of the leaves ; as the necrosis increased, the leaves dried up; poor growth and also root system not properly developed ; ear-head appeared but later than in the case of normal plants	Tips showed burning effect which was followed latter by development of necrotic spots along the margins of the leaves; as the necrosis increased; the leaves dried up poor growth and also root system not properly developed; ear-head appeared but later than in the case of normal plants

The results of the analysis of the plant leaves grown in sand-culture are presented in Tables II to VI.

TABLE II—*Boron and calcium contents of bean leaves as affected by different boron treatments* (oven-dry basis)

Concentration of boron in nutrient solution (p.p.m.)	Calcium mg./g.	Boron mg./g.	Ca : B.
0·000	5·0	0·015	333·3
0·001	6·5	0·036	180·6
0·01	10·4	0·060	173·3
0·10	12·4	0·080	155·0
0·50	9·2	0·178	51·7
5·00	14·7	8·750	1·7
50·0	16·3	10·000	1·6

TABLE III—*Boron and calcium contents of tobacco leaves as affected by different boron treatments* (oven-dry basis)

Concentration of nutrient solution in p.p.m.	Calcium mg./g.	Boron mg./g.	Ca : B
0·000	9·6	0·025	384·0
0·001	11·6	0·050	232·0
0·01	14·0	0·065	215·4
0·1	16·8	0·120	140·0
0·5	18·2	0·180	101·1
5·0	30·0	1·650	18·2
50·0	70·5	6·000	11·8

TABLE IV—*Boron content of onion leaves as affected by different boron treatments* (oven-dry basis)

Concentration of boron in nutrient solution (p.p.m.)	Calcium mg./g.	Boron mg./g.	Ca : B
0·000	12·0	0·024	500·0
0·001	13·0	0·10	130·0
0·01	14·0	0·13	107·7
0·10	14·8	0·19	78·0
0·50	14·2	0·22	64·5
5·0	16·0	3·20	5·0
50·0	12·0	8·00	1·5

TABLE V—*Boron and calcium contents of* guvar *leaves as affected by different boron treatments*
(oven-dry basis)

Concentration of boron in nutrient solution (p.p.m.)	Calcium mg./g.	Boron mg./g.	Ca : B
0·000	13·5	0·040	337·5
0·001	14·4	0·047	306·4
0·010	14·6	0·060	243·3
0·10	18·4	0·120	153·3
0·50	20·1	0·270	74·4
50·0	31·2	2·000	15·6

TABLE VI—*Boron and calcium contents of* bajri *leaves as affected by different treatments*
(oven-dry basis)

Concentration of boron in nutrient solution (p.p.m.)	Calcium mg./g.	Boron mg./g.	Ca : B
0·000	18·0	0·015	1200·0
0·001	20·0	0·027	740·7
0·01	..	..	..
0·10	21·0	0·040	525·0
0·30	21·0	0·065	323·6
0·50	25·0	0·105	238·1
50·0	23·0	0·230	100·0

It is observed that as expected there is a continuous rise in the boron content of the dry matter with increasing amount of boron in nutrient solution. Considering the Ca : B ratios, it is found that plants receiving the lowest levels of substrate boron have the highest Ca : B ratios, and those receiving the highest levels of boron the lowest ratios. In the case of tobacco, it is found that when the Ca : B ratio is more than 101·1 the growth is poor, and severe deficiency symptoms are observed when this value is as high as 384. When the value decreases to about 18·2 or less, distinct injurious effects are noted. In beans, only when this ratio is more than 173·3, deficiency symptoms are noted. Good vegetative growth is observed when the ratio is between 155·0 to 173·3. The growth is depressed when the ratio is 51·7, but when the ratio falls to 1·7, severe toxicity symptoms are seen. For normal growth of onions, it seems that a ratio between 78·0 and 107·7 is the most suitable one. If it reaches 130 or above, deficiency symptoms appear. Severe toxicity symptoms are obtained at ratios below 5·00. The results show that of all the crops studied, *bajri* gives highest ratios for all concentrations of boron showing that absorption of boron by *bajri* is small. Even when there is a fluctuation from 323·0 to 525·0, the plants grow well; when the Ca : B ratio has a value more than 740·7, the growth is found to be poor. Injurious effects are obtained when the ratio is 238·1 or less. *Guvar* seems to have almost similar ratio as that of beans for its normal growth (153·3). When the ratio is 306·4 and above, deficiency symptoms are marked. When this ratio is 74·4, some injurious effect is noted and marked injury is noted when the ratio reaches 15·6. It can be seen that different types of plants have got their own specific values of Ca : B ratio for normal and healthy growth.

SUMMARY

1. Deficiency and toxicity symptoms of five common crops of Gujarat, viz., Indian bean, tobacco, onion, *guvar* and *bajri* are studied using sand-culture technique and applying nutrient solutions containing all necessary ingradients except boron which is applied in concentrations varying from 0·001 to 50·0 p.p.m. The symptoms observed are somewhat similar except with certain differences. The observed deficiency symptoms are : in Indian bean interveinal chlorosis, dark and brittle new-coming leaves, water-soaked areas in leaves, delaying of flowering and formation of seedless pods ; in tobacco dark green brittle leaves curling towards the base, growing point turning brown ; in onions chlorosis of the tip of the leaves, ladder-like rings in the new-coming leaves and stunted growth ; in *guvar* chlorosis of basal leaves, thin stem and suppression of vegetative growth ; in *bajri* pale green leaves, yellowing at the tip of leaves, short internodes and stunted growth. The observed toxicity symptoms are : in Indian beans, slight chlorosis followed by dark brown spots on the leaves, marginal scorching on the periphery of the leaves and stunted growth; in tobacco, brown circular spots on the periphery of the leaves and stunted growth; in onions, burning of the tip of the leaves gradually increasing up to base, and no development of bulb ; in *guvar*, marked burning at the base of the leaf followed by angular scorching and leaves curling upwards and stunted growth ; in *bajri*, burning effect of the tip of the leaves followed by necrotic spots along margins of leaves and stunted growth.

2. The growth of onion, bean and *bajri* is normal when the nutrient solution contains 0·01 p.p.m. boron. Normal level for *guvar* is 0·1 p.p.m. and that for tobacco 0·5 p.p.m. in nutrient solutions. This shows that tobacco has high requirement of boron and onions, beans and *bajri* have a low requirement, while requirement of *guvar* is intermediate.

3. The boron contents of normal crops grown in nutrient solution are : bean, 0·06 to 0·08 mg.; tobacco, 0·18 mg.; onion, 0·13 to 0·19 mg.; *guvar*, 0·12 mg. and *bajri*, 0·04 to 0·065 mg. per gm. of oven-dry matter.

4. Injury due to boron deficiency is observed in bean, onion and *bajri* at 0·001 p.p.m., in *guvar* at 0·01 p.p.m. and in tobacco at 0·1 p.p.m. boron levels of the nutrient solutions. Injury due to toxicity is observed at 0·5 p.p.m. level in nutrient solution in all crops except tobacco in which symptoms of toxicity are observed at 5 p.p.m. level.

5. Plants make normal growth when a certain balance in Ca : B intake exists. Different types of plants have their own range of Ca : B ratio for normal and healthy growth below which the plants suffer. Ca : B ratios observed for normal and healthy growth are—bean : 180·6, tobacco : 101·1, onion, 78·0 to 107·7, *guvar*: 153·3 and *bajri*: 323 to 525·0.

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A NOTE ON THE CONTROL OF THE BRINJAL SHOOT AND FRUIT BORER—*LEUCINODES ORBONALIS* G.

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Leucinodes orbonalis G. is a serious pest of brinjal in the Madras State. It damages the shoots and fruits to a considerable extent. The adult is a grey brown moth, with whitish wings and pink markings. The caterpillars are short, stout and pink in colour. They bore into the top shoots of young plants and cause withering. The damage to the shoots is negligible while that to the fruits is far more serious since more than 50 per cent of the produce is infested and the edible quality is practically ruined. In this note, an account on the control of the pest, based on a simple randomised replicated trial, laid out at Coimbatore during the monsoon season, 1956 using some of the modern insecticides is given.

Banerjee and Basu [1952] have found DDT spray (1·0 per cent) a most effective treatment against this borer. Experiments conducted by the Government Entomologist, Coimbatore, during 1954, indicated the superiority of calcium arsenate spray over DDT, BHC and certain other vegetable poisons. Mechanical removal and destruction of affected fruits is reported to be a very efficient and cheap method of control by Wesley [1952]. Banerjee and Basu [1956] have recommended two applications of Endrin (0·08 per cent) emulsion; the first application to be made three weeks after transplanting and the second three weeks later. In summer 1956 at the Agricultural Research Institute, Coimbatore, under the auspices of the Vegetable Research Scheme, a pilot trial against this pest was laid out in observational plots of 42½ ft. × 15 ft. with the variety 'Okhla'. There were six treatments and one control. The treatments were applied six times at fortnightly intervals. Lindane 0·1 per cent followed by Dieldrin 0·1 per cent, Endrin 0·02 per cent and DDT 0·1 per cent reduced the borer incidence in the fruits from 54·0 per cent in the control to 11·6 per cent, 15·8 per cent, 20·0 per cent and 24·0 per cent respectively. Parathion 0·025 per cent and calcium arsenate and lime mixture (1 ounce + 1 ounce respectively in one gallon of water) displayed 56·7 per cent and 48·0 per cent borer attack on fruits.

MATERIAL AND METHODS

Seedlings of 'Okhla' variety found highly susceptible to attack by borers, at uniform age of 42 days were planted in 24 plots of 50 ft. × 10 ft. There were five treatments and one control. Each variant was replicated four times in simple randomised blocks. In each plot, there were 80 plants of which one guard row of 44 plants alround were discarded. The net size of each plot was 45 ft. × 5 ft. with 36 plants. The treatments were applied five times at fortnightly intervals. In all, the fruits were collected 14 times ; the borer incidence on the shoots was observed six times at regular intervals. The efficacy of the treatments was assessed by the percentage of bored fruits on number and weight basis. Those fruits which displayed bore holes were taken as infested ones and those that did not display bore holes were taken as healthy ones. The results are set out below. The data on the mean percentage of borer incidence on fruits under the different variants (number and weight basis), the mean percentage of shoot borer incidence and the mean yield of good fruits (number and weight) and the income from the borer free produce on account of the various treatments are given in the Table I.

RESULTS

It is seen that Lindane 0·1 per cent has been able to control the brinjal fruit borer effectively, but the cost is not commensurate with the extra yield and a lower dosage has to be tried. Lindane 0·1 per cent is followed by Endrin 0·02 per cent, DDT 0·1 per cent and Dieldrin 0·1 per cent there being very little difference among them in reducing the ncidence of

TABLE I—*Data on mean yield of borer-free produce, percentage of infestation on fruits and shoots, and the net income from the borer-free produce in an acre under the various treatments*

Treatments	Mean weight of borer-free produce in 225 sq.ft. area (a)	Mean number of borer-free produce in 225 sq. ft. area (b)	Mean percentage of borer infestation on fruits (weight basis) (c)	Mean percentage of borer infestation on fruits (No. basis) (d)	Mean percentage of borer infestation on shoots (e)	Net income from borer-free produce in an acre at As. 2 per lb.
	Lb. Oz.					Rs. As. ps.
Lindane 0·1 per cent (6·5 per cent W.P.—2½ oz. in one gallon of water)	43 10	323	1·4	1·7	0·13	618 12 0
Endrin 0·02 per cent (19·5 per cent E.C.—one oz. in 6¼ gallons of water)	34 3	265	12·2	12·1	0·95	718 12 0
D D T. 0·1 per cent (50 per cent W.P.—one oz. in 3 gallons of water)	47 12	369	12·3	12·2	4·6	1109 6 0
Dieldring 0·1 per cent (50 per cent W.P.—one oz. in 3 gallons of water)	34 5	265	16·1	14·2	0·23	540 10 0
Parathion 0·025 per cent (one oz. of 46·7 per cent emulsion in 12½ gallons of water)	19 3	141	48·9	58·9	6·6	268 12 0
Control (plain water treated)	2 15	30	42·7	46·3	12·7	75 0 0
Critical difference	19 15	56·4	5·25	4·8	5·79	

Bar diagram : (a) 3,1,4,2,5,6; (b) 3,1,4,2,5,6; (c) 1,2,3,4,6,5; (d) 1,2,3,4,6,5; (e) 1,4,2,3,5,6.

Leucinodes orbonalis on fruits. DDT 0·1 per cent compares favourably with other treatments in keeping down the borer infestation as well as the cost of treatment.

DDT 0·1 per cent and Lindane 0·1 per cent have given the highest yield of borer-free fruits. Among the four treatments, DDT 0·1 per cent, Lindane 0·1 per cent, Dieldrin 0·1 per cent and Endrin 0·02 per cent, there is not much difference in respect of yield of good fruits by weight. But DDT 0·1 per cent and Lindane 0·1 per cent have given higher yields than other treatments. There is not much difference in respect of yield among the treatments,i.e. Parathion 0·025 per cent, Endrin 0·02 per cent and Dieldrin 0·1 per cent.

Lindane 0·1 per cent, Dieldrin 0·1 per cent and Endrin 0·02 per cent control the shoot borer incidence better than DDT 0·1 per cent and Parathion 0·025 per cent.

ACKNOWLEDGEMENT

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PREPARATION OF PECTIN, PECTIN EXTRACT AND SYRUP FROM JACK FRUIT RIND

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Pectin which is an important constituent of various plant materials, plays a significant role in giving a good set to jams and jellies prepared from their extracts. As it is a costly material, the possibility of recovering pectin from rind and core of jack fruit was examined. Krishnamurti and Giri [1949] studied the preparation and composition of pectin from the seeds, kernel and pericarp of jack fruit, and found pericarp and kernel to be rich sources of pectin.

Jain and Lal [1955] have described the method of preparation of high grade pectin (200 grade) from jack fruit wastes. Yields of pectin obtained from different parts of ripe jack fruit wastes and rind and core of raw jack fruit are given in Table I.

Table I—*Yield of pectin from jack fruit wastes*

Material	(Per cent yield of fresh material)	
Outer spiny rind portion	0·78	
Inner fluffy portion of rind core	1·72 1·15	Average 1·22 per cent
Rind and core of raw jack fruit	0·47	

Table I shows that whereas the average yield from rind and core of ripe jack fruit is 1·22 per cent, it is only 0·47 per cent in the case of raw jack fruit. Probably, the pectin is built in rind during the ripening process. Further, the pectin content is maximum in the inner fluffy portion of the rind of ripe jack fruit.

The quality of pectin prepared from this fruit compared favourably with that of other commercial pectins. It was of about 200 jelly grade in strength and could be prepared at a cost of Rs. 10 to 15 per lb.

Pectin extract : Instead of recovering pectin from the concentrated extract containing 20-25 per cent soluble solids, it is cheaper to preserve it as pectin extract which can be conveniently used for jelly making. For this purpose, 0·3 per cent citric acid is added to the rind before taking the extract. It can be preserved by filling hot into bottles or plain cans which are previously sterilized in boiling water for half an hour. It keeps well in storage at room temperature (24-30°C.) for more than a year.

Test jellies : Table II summarizes the data on the preparation of jellies using different amounts of extract and citric acid. The weight of the final jelly was 101 gm. in each case and 35 mil. of water was added to facilitate dissolution of sugar.

Table II shows that even 5 gm. of this extract is capable of setting 65 gm. of sugar if the *p*H is properly controlled by adding enough citric acid. Addition of 0·7 gm. citric acid for 100 gm. of finished jelly is quite sufficient to bring down the *p*H to about 3·50. The set of jellies was good between 3·1 and 3·5. Siddappa and Bhatia [1952] also stressed the importance of *p*H adjustment in the preparation of jellies from jack fruit rind extract having 7 per cent soluble solids and 4·2 *p*H.

TABLE II—*Preparation of test jellies from jack pectin extract*

Item No.	Weight of extract (g.)	Sugar added (g.)	Citric acid added (g.)	Refracto-meter solids of jelly	*p*H of jelly	Set of jelly	Taste and appearance
1	10	65	0·35	70	4·10	Not set	Good
2	10	65	0·50	70	3·60	Syrupy	do.
3	10	65	0·75	71	3·25	Good set	do.
4	10	65	1·00	70	3·10	do.	do.
5	20	63	0·70	71	3·50	do.	do.
6	30	61	0·70	70	3·50	do.	do.
7	40	59	0·70	69	3·50	do.	do.
8	5	65	1·00	70	3·10	do.	Good, slightly tart
9	8	65	1·00	71	3·10	do.	do.

Jack pectin extract can be used to supplement the pectin content of various fruit extracts used for the preparation of jellies when they are found deficient in it.

Syrup from jack rind : Jack fruit rind contains about 8 per cent sugars [Bhatia, *et. al.* 1955]. Efforts were made to prepare a fruit syrup from this waste material. Extract is taken from the sliced rind as for the preparation of pectin extract after steeping in 0·1 per cent potassium metabisulphite for 18 hours. Citric acid at the rate of 0·3 per cent is also added to the rind before taking the extract. The combined extract with water using twice the weight of rind has 5-6 per cent soluble solids and a *p*H of 4·9.

Experiments on clarification : Pectinous material is removed by treatment with lime. Calcium oxide is added as a water suspension to the boiling extract at the rate of 3 oz. per 100 lb. A flocculant precipitate is formed. Addition of excess of lime should be avoided as optimum *p*H for precipitation is about 7·5-8·0, which is obtained by adding lime at the rate stated above.

The lime-treated extract is allowed to stand in deep vessel for 3-4 hours and the upper clear liquid syphoned off. It is not possible to filter the pectinous material at the bottom by means of a filter press using hyflo supercel. Centrifuging is also not helpful. Increase or decrease of *p*H after adding HCl of NaOH fails to clarify it.

The syphoned liquid is deep orange brown in colour. The colour is water soluble and is not extracted by petroleum ether or acetone. Addition of 0·5 per cent hyflo supercel or 0·1 per cent activated charcoal to the boiling solution failed to decolourise it. Addition of acid or potassium metabisulphite reduced the intensity of the colour to some extent, but did not reduce the final colour in the concentrated syrup. Treatment with activated carbon before liming also failed to prevent colour development on subsequent liming.

Carbon dioxide passed through lime-treated extract did not precipitate calcium either in the cold or on heating.

Clarification of the extract was also tried with the help of tannin and gelatin either alone or in combination. Addition of tannin and gelatin ranging from 0·005 to 0·05 per cent failed to clarify the extract in the cold or on heating. Addition of 0·025 per cent tannin followed by 0·25 per cent gelatin, was equally ineffective. Lowering the *p*H of the extract before adding tannin and gelatin was of no use.

From the above experiments, it was concluded that clarification could only be effected by lime treatment, although it imparted a deep orange brown colour and slightly alkaline taste to the finished product.

Preparation of syrup and its analysis : The lime treated and syphoned extract on concentration under reduced pressure to 66 per cent refractometer solids gave a deep orange brown flowing syrup having alkaline taste. On analysis it gave the following values :

Refractometer solids at 20° C: per cent	= 66·0
Reducing sugars (as invert) per cent	= 24·66
Total sugars (as invert)	= 33·72
Total ash per cent	= 9·59
Acidity (as citric) per cent	= 0·73
Calcium per cent	= 0·84
*p*H	= 4·82

The high ash content makes the syrup unsuitable for edible purposes. It may, however, be used for tobacco curing and for that purpose, it can be prepared cheaply by boiling the cold water extract left after steeping the rind in 0·1 per cent potassium metabisulphite solution, the rind being used for preparing pectin or pectin extract.

These experiments show that crude syrup, pectin and pectin extract are the products which can be simultaneously produced from jack fruit wastes.

SUMMARY

1. Method of preparing pectin from different portions of jack rind of ripe jack fruit and rind and core of raw jack fruit has been mentioned.

2. Average yield of crude pectin from rind and core of ripe jack fruit is 1·22 per cent as against 0·47 per cent only in the case of raw jack fruit. Pectin content is maximum in the inner fluffy portion of the rind of ripe jack fruit.

3. Jack pectin extract containing 20-25 per cent soluble solids can be conveniently prepared from jack rind. Even 5 gram of this extract is capable of setting 65 gram of sugar if the *p*H is properly controlled by adding enough citric acid.

4. Method of preparing crude syrup from jack rind is described. Its analysis has been reported. Because of its high ash content, the syrup is not considered suitable for edible purposes. It may, however, be used for tobacco curing.

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REVIEWS

PRACTICAL MICROSCOPY

By L. C. Martin and B. K. Johnson, Blackie & Sons Ltd., London, Glasgow, Third Edition. 1958; pp. 138; Price 8sh. 6d.

This is a book which deals with the design of microscope and microscopic techniques. The microscope is an instrument which is very commonly used in almost all branches of scientific study and research. An appreciation of the microscope as a tool of scientific work and some amount of skill in its manipulation are absolute pre-requisites of a scientific worker in many fields of study. It is on this dexterity that appropriate interpretations of observations made to a larger extent depend. This book has been planned to give the reader an idea of the design of the microscope and various other aspects of the instrument. There are 14 chapters in which the following subjects are dealt with : magnification, mechanical parts, objectives and eyepieces, numerical aperture, methods of illumination, dark-ground and phase microscopy, photomicrography, the metallurgical microscope, preparation of specimens for the microscope, binocular microscopes, polarised light and the microscope, ultra violet microscopy, the interpretation of the image in the microscope and the electron microscope. There is also an appendix in which routine procedure for photomicroscopy and data regarding light-sources have been dealt with. A list of important books on various phases of the subject matter has been included to help the reader interested in obtaining further and fuller information. The book is well written ; the language is simple and precise and the illustrations are helpful for understanding the text. It will surely be found useful to all research workers who have to deal with the microscope in their programme of work. The mere facts that the book has been reprinted a number of times, and that it has been necessary to bring out a third edition indicate the usefulness of the book to all those for whom it is intended.

THE NEW INDIA—PROGRESS THROUGH DEMOCRACY

Published by the Planning Commission, Government of India; The Macmillan Company, New York, Toronto, London, Manila; (1958). Price $ 2·50.

The aim of this book has been stated in the Introduction by V. T. Krishnamachari, Deputy Chairman of the Planning Commission of India, in the following words:

"Since the Parliament of India gives its approval to the Second Five-Year Plan, the need has been felt for a publication which would set out for readers abroad the underlying approach and main features of India's economic and social programmes. This volume is an attempt to meet this need. It has been prepared at the request of the Planning Commission by a special study group." This book contains " an objective presentation of the principles and aims of the Second Five-Year Plan and the programmes of development embodied in it".

The first 127 pages of the book are devoted to the background against which the Second Plan had been conceived. It also gives an outline of the Second Five-Year Plan. These preliminary chapters are followed by a discussion of the development programmes. Thereafter the book is divided into three distinct sections. The first section is devoted to agricultural and rural development and deals with rural problems of India, community development, land reforms, rural credit, agriculture, irrigation and power. The second section deals with industrial development and discusses such subjects as medium and large scale industries, village and small scale industries, mineral development transport, communications, and scientific and technical research.

The third section surveys the field of social services including such subjects as education, labour, health, housing and urban development, advancement of tribal peoples and rehabilitation of displaced persons.

There is an appendix in which the Government of India's industrial policy resolution has been reproduced.

The whole book is delightfully written, contains material facts relating to Second Five-Year Plan and will certainly be looked upon as an authoritative statment of the Plan and the programmes formulated for its implementation. The language is easy, sufficiently elastic and appealing so as to draw the readers' attention. The book is written with an understanding of the Indian background against which major problems have been discussed. It is neatly printed, contains a number of illustrations and has a pleasing get-up.

GENERAL MICROBIOLOGY

By Roger Y. Stanier, Michael Doudoroff and Edward A. Adelberg; Macmillan & Co. Ltd., London [1958] pp. 682; Price 50 sh.

Microbiology as a distinct scientific discipline, or as an adjunct of the biological sciences, is gradually gaining importance. It is being increasingly included, or otherwise stressed, in various courses of study in universities and colleges and also in the specialised curricula relating to agriculture, veterinary science, medicine and public health. Microbiological processes are of great significance and are widely used in many essential industries. It is, therefore, increasingly realised that, apart from sepcialised training, a knowledge of microbiology should feature in any scheme of liberal education. It is this awareness which has promoted production of suitable literature which seeks to convey an idea of the scope and contents of the subject of microbiology. The book under review entitled *General Microbiology* is one such publication; it further justifies its appearance because such general texts are needed which can easily fit into formal courses of study. As the authors point out, this book is an attempt to present modern synthesis of microbiological knowledge in a form intelligible to the beginner.

The book is a comprehensive one and is divided into three parts. The first part deals with the properties of micro-organisms and is divided into 19 chapters which contain a treatment, among others, of such diverse but interrelated topics as the discovery of micro-organisms, microbiological methods, position of micro-organisms in the living world, the anatomy of the bacterial cell, microbial physiology, respiration, growth, nutrition, cultivation of bacteria, classification, the viruses, and mutation, selection, adaptation and evolution of bacteria. The second part deals with the ecology of micro-organisms and discusses such subjects as micro-organisms as geochemical agents, symbiotic relationship of micro-organisms to plants and animals, host-parasite relationship, principles of chemotherapy, dynamics of disease in populations, some infectious diseases of man, bacterial diseases of plants, industrial uses of micro-organisms, and some other cognate of topics. The third part is devoted to a discussion of the biological concepts as would help to comprehend the principles of microbiology; in this section are considered the composition, structure, and reproduction of living organisms; genetics, evolution and classification; and physiology emphasising biochemistry and nutrition.

There is at the beginning of the book a list of selected bibliography which would be of great help to the readers who want to get further information relating to various topics. In the end the text is followed by an exhaustive index. The book is very wide in its scope and deals with all possible aspects of microbiological science. The treatment is coherent, logical and systematic; and the manner of presentation is such as to develop interest of the readers in the subject. The language is crisp, precise and simple, and serves to hold the reader's attention. The publication will surely be of great help to the students of microbiology in Universities and colleges, both as a text and reference book.

The book is well produced, neatly printed and securely bound.

THE FARMERS AND FARM STUDENT'S HAND-BOOK

By James Gunston; Odhams Press Limited, London; 1956. 320 pages. Price 18 sh.

This is a hand-book on agriculture and animal husbandry in which various details relating to crop growing and livestock raising have been dealt with in a clear, precise and practical manner. The book is more of a nature of a reliable guide literature to working farmers, amateur gardeners and students of agriculture and animal husbandry than an exhaustive learned treatise on various aspects of agricultural science. It is meant for the man who wants to work with his hands and develop his land either for food production or livestock raising. The book is divided into eight chapters in which such topics are dealt with as various types of crops and their culture, livestock management, manurial requirements of crops, gardening in different times of the year, beneficial birds and insects, vermin control and insect pests; a chapter is devoted to weights, measures and Tables. There is an appendix which lists some new cereal varieties bred in Britain. Each of the chapters is well-written with practical suggestions for good agricultural operations and raising of livestock. The chapter on beneficial birds and insects is full of useful information and that on vermin control gives instructions by which the activities of such destructive animals could possibly be kept under control. The chapter on weights and measures is especially helpful because such information is not generally included in many available books of this kind. The book is written in an attractive style without any pretentions to pedantic verbosity. Although the information contained relates to British farming practices, the working farmers elsewhere also can depend on a book like this as also students and amateur gardeners. The fact that a reprint of the book has been necessary in about a year's time indicates that it has been well received by those for whom it is meant. It is neatly printed and well produced with strong cardboard binding.

SOIL-PLANT RELATIONSHIP

By C. A. Black; (1957). John Wiley & Sons, Inc., New York; Chapman and Hall Ltd., London. 332 pages; Price $ 7.

This book contains an up-to-date statement of the various aspects of the relationships that exsit between plants and the soil as a substrate for plant growth. All the important aspects of the properties of the soil are dealt with more or less thoroughly and the complex pattern of soil-growth relationships are brought out clearly so as to allow easy comprehension. A book of this type is likely to suffer from two rather common defects; either it is overburdened with voluminous technical data far too much to be suitably grasped by the reader or it is so much oversimplified that it ceases to be a standard technical publication. The author of this particular book has, however, very judiciously avoided the two extreme styles of treatment; too many technical details, which only a seasoned specialist would require, have been omitted, while enough data have been included and critically elaborated to make the book useful even to students of advanced studies. It has, therefore, been possible for the author to present the various aspects of plant-soil complex with insight and imagination. The plant responses have been interpreted as indicative of the inter-action of various factors which operate in the soil and which condition plant growth. The environmental as well as the nutritional aspects of the soil have been emphasised. The book is divided into nine chapters which include discussions of such important subjects as soil composition, soil water, soil erosion, exchangeable bases, soil acidity, soil salinity and alkalinity, and nitrogen, phosphorus and potassium. Each chapter is followed by a list of selected references which will help the inquisitive reader to obtain more detailed information than is given in the text. In addition, there is an index which would help in locating any particular subject dealt within the book. In the discussion on various subjects, there is evidence of realisation that the dynamics of research are opening up new vistas in various fields and increasing knowledge by the addition of factual data, leading to changes in viewpoints. But even then tentative conclusions can always be drawn, based on available data and observations which research may or may not confirm. It is pleasing to observe that this expanding scientific horizon has always been kept in view in the discussions outlined in the book. Wherever necessary, controversial problems have been left open with indications as to the side the present state

of research is inclined to favour. The language of the book is precise, scientific and impressive, and the style pleasing and attractive, with factors which are calculated to draw and sustain attention of readers. Interspersed in the text are a large number of Tables and graphs. The book will certainly be of great help to persons interested in soil science, agronomy, general agriculture, plant physiology and other related fields of study. It is neatly printed and well produced with durable cardboard binding; a simple cover jacket has also been provided.

COTTON

By Harry Bates Brown and Jacob Osborn Ware; McGraw Hill Co., New York, Toronto, London; Third edition, 1958; pp. 566; Price $. 12·00.

This is the third edition of a well known book on Cotton which first came out in 1927. Ever since the book was published, it has been widely used as a text and reference book by all interested in this commodity. As stated in the Preface the object in producing the third edition of this book was to bring it up-to-date incorporating new information generally not available in the former editions when they were published. There are 25 chapters which deal with history of cotton and cotton industry; taxonomy of the cotton plant; cultivated varieties of cotton; standardisation of cotton varieties; morphology of the cotton plant; variation, heredity and correlation of characters in cotton plants; problems and methods in cotton breeding; cotton diseases; cotton insects; chemistry of cotton plant; physiology of the cotton plant; climate and soils for cotton; soil fertility and cotton production; cotton culture; cotton harvesting cotton ginning; cotton fibres; cotton classing; cotton marketing; cotton future exchanges; cotton as a textile; cotton manufacturing; cottonseed processing and products; commercial status of cotton and cotton statistics. In its broad sweep the book includes almost everything concerning cotton—its various phases of production, technology and marketing as also its bye-products, and the problems connected with these. The treatment is both extensive and intensive—extensive in relation to the widely scattered information which have been conveniently put together and intensive because of the depth of treatment of individual subject matters. A sober, scientific and scholarly presentation is very much in evidence throughout the volume; the language used is simple, lucid and impressive. Each chapter is followed by a list of references which will enable the interested reader to trace the original sources of information. There is an exhaustive index which will be of help to any one who wants to locate any particular subject dealt with in the book. The fact that the third edition of this book has been called forth testifies to its great popularity and also its general usefulness. In its third edition, the book like its predecessors, will be of immense value to the students, research scholars, technologists and the trade. It is very well produced, neatly printed and amply illustrated, and has a pictorial cover jacket which is delightfully simple in design.

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Reference to literature, arranged alphabetically according to authors' names should be placed at the end of the article, the various references to each author being arranged chronologically. Each reference should contain the name of the author (with initials), the year of publication, title of the article, the abbreviated title of the publication, volume and page. In the text, the reference should be indicated by the author's name, followed by year of the publication enclosed in brackets ; when the author's name occurs in the text, the year of publication only need be given in brackets. If the reference is made to several articles published by one author in a single year, these should be numbered in sequence and the number quoted after year both in the text and the collected references.

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